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THE FORMATION AND TREATMENT OF FIBRO-ADENOMAS OF THE BREAST

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In an article [1] I wrote in 1923, I described for the first time a fibro-adenoma of the breast that began in the intra-elastica tissue of that gland. I feel sure it is a more common tumor than is generally supposed. I also described the formation of fibro-adenomas in general. The article to which I refer contains matter relating to other states of the breast and my description of fibro-adenomas in particular was rather buried among the other material. I am glad to have this opportunity of calling particular attention to the formation of fibro-adenomas only. I do not consider that any types of fibro-adenomas arise from so-called "rests," and it will be seen that I believe that they originate in parts of the gland that have been normal.

Figure 1 shows the two tissues from which the varieties of fibro-adenomas originate. The first tissue (fig. 1 *G*) I shall describe is that which exists immediately inside the elastica (fig. 1 *H*); the second tissue is the pericanalicular and periacinous connective tissue that immediately surrounds the ducts and acini (fig. 1 *K* and K_1) and which, with the ducts and acini it surrounds, is embedded in the general supporting fibrous tissue of the breast (fig. 1 *L*). For want of better descriptive terms, I shall describe those changes which occur in the connective tissue immediately internal to the elastica under a heading of "intra-elastica," and those changes which occur in the pericanalicular and periacinous connective tissue of "extra-elastica," although the pericanalicular tissue is not immediately external to the elastica but is separated from it by the structures composing the duct wall. Hence it is important to describe the distribution of the elastica of a normal breast. This tissue surrounds all ducts and terminates abruptly when the acinus

1. Cheatle, G. L.: Hyperplasia of Epithelial and Connective Tissues in the Breast: Its Relation to Fibro-Adenoma and Other Pathological Conditions, Brit. J. Surg. **10**:436 (April) 1923.

is reached. It is not uncommon in some breasts for the elastica to surround or partly surround at least some acini in a lobule. When this occurs the elastica of the acini and ducts is continuous. Occasionally the elastica surrounds a lobule. The intra-elastica tissue normally consists of bipolar cells which are sparsely scattered in very delicate fibrillous tissue. Separating this tissue, which is immediately internal to the elastica, from the epithelium lining, the ducts and acini, is a single continuous layer of nonstriated muscle fiber (fig. 1 *E*). This intra-elastica tissue is present in all ducts and acini. It surrounds the latter even when the elastica is not continued around them (figs. 1, 2, 3 and 4). It is from these two component parts of the intra-elastica connective tissue that the intra-elastica fibro-adenomas arise; hence, it is not uncommon to notice strands of nonstriated muscle fibers scattered about in the connective tissue of the fibro-adenomas belonging to this class.

I. INTRA-ELASTICA FIBRO-ADENOMA

Hyperplasias of the intra-elastica tissue occur in older women than those of the extra-elastica type and usually all forms of it affect women who are in the late thirties and onward. Both types usually affect the terminal parts of the ducts and acini. Hyperplasia of this tissue I divide into two parts: (*a*) diffuse and (*b*) local.

(*a*) *Diffuse.*—In this type there is a general, more or less uniform, hyperplasia of the tissue (figs. 2 and 3) which early undergoes degeneration (fig. 4), and instead of being composed of recognizable cellular tissue it appears as a uniform state in which no cells can be detected; it stains diffusely. It affects discrete portions of the gland and I have never seen it generalized throughout the whole gland. It appears clinically when it affects ducts and acini as a localized lumpiness and is always diagnosed in that meaningless term "chronic mastitis." Needless to say, it has nothing to do with inflammation. It may affect terminal parts of ducts alone, acini alone, or terminal parts of ducts and acini (figs. 2 and 4).

(*b*) *Localized.*—The hyperplasia in this state is represented by a well marked tumor and forms one kind of intracanalicular fibro-adenoma. The tumor may be represented by a purely acinous fibro-adenoma (fig. 5), or by a pure intracanalicular duct fibro-adenoma (figs. 6 and 7). Both states respectively represent a single tumor. The acinous intra-elastica fibro-adenoma (fig. 5) never attains a large size and usually is discovered accidentally in examinations of the breasts for other lesions. The intra-elastica duct fibro-adenoma (fig. 7), on the other hand, appears as a definite tumor and therefore becomes of greater clinical

importance. The duct intracanalicular fibro-adenoma of this type arises from the diffuse affection of the duct and appears as a definite lobulated tumor, the connective tissue of which is composed of delicate fibrous tissue in which bipolar and ordinary cells are separated from each other by more or less delicate connective tissue fibers, among which can be seen separate and irregularly distributed strands of nonstriated muscle fibers. An early stage of this tumor formation is seen in figure 6. The epithelium covering the connective tissue is of healthy appearance, not so columnar in type as in normal breasts, and from this lining of epithelium, processes dip down into the connective tissue and form definite, vigorous, normal looking acini (fig. 8). Also, papillomatous processes from which secondary papillomatous processes grow may arise from the surface of the tumor and give rise to very complicated appearances (fig. 9). The patient from whom the sections were taken was 51 years of age and it is extraordinary to note how young and vigorous are the new epithelial formations in the tumor.

II. EXTRA-ELASTICA FIBRO-ADENOMA

The connective tissue in which the following changes begin is the pericanalicular and periacinous connective tissue that immediately surrounds ducts and acini (fig. 1 *K* and K_1). It separates these structures from the more dense and coarse supporting connective tissue of the breast (fig. 1 *L*) and, pathologically, is a more important tissue than the latter. There is no increase in ducts or acini in this type of disease. The changes occur in preexisting ducts and acini and hence it differs materially from the intra-elastica localized fibro-adenoma which occurs in the ducts and which I have described above. The changes I am about to describe occur in females of all ages from adolescence onward. Like the intra-elastica fibro-adenomas, the changes occur in the terminal parts of the ducts and acini, and also as (*a*) diffuse and (*b*) localized changes.

(*a*) *Diffuse Hyperplasia of the Extra-Elastica Fibrous Tissue (Diffuse Fibro-Adenomatosis)*.—This may affect nearly the whole breast, giving rise to the appearance of a generalized fibro-adenomatosis. In this diffuse state parts can be seen in which the changes are more isolated than elsewhere (fig. 10). This isolated part exactly resembles those changes which I described under (*b*) the localized form. The epithelial change occurring in this state is mainly one of desquamative hyperplasia within the lumina and are characterized by their small, desiccated appearance and by their unwillingness to take up the stains. The diffuse form generally occurs after the age of about 30 years, and some observers do not consider that this diffuse fibro-adenomatosis is of

precisely the same character as that which is occurring in the localized form. I can only say there is no difference between the localized and diffuse forms in their growth and microscopic appearance. I regard both states as being primary and not merely the result of chronic inflammation.

(*b*) *Localized Hyperplasia of the Extra-Elastica* (*Fibro-Adenoma*). —The terminal ducts and acini are, as a rule, the only parts involved in this tumor. The epithelial changes are the same desquamative type that occur in the diffuse form. The coarse fibrous tissue which supports the breast is pressed on by the growing tumor and here there are appearances that give rise to the false conception of a capsule. I have never been able to detect a real capsule to any of these tumors. It is important to observe that the tumor increases in size by two methods. The first is a continued growth of periacinous and pericanalicular connective tissue that was first affected (fig. 11 *A*), and the second an increase of the pericanalicular and periacinous fibrous tissue of fresh ducts and acini (fig. 11 *B* and *C*). The latter may be in juxtaposition to the original tumor, or they may be separated from it by parts of the breast that appear to be nearly normal. Lobulation of the tumor is accounted for in this way. The importance of this observation determines the inevitable conclusion that even a localized fibro-adenoma is really a process affecting consecutively parts in a localized area of a gland that had been normal. The ducts and acini in these tumors may become cystic. Into the cysts may grow intracanalicular and intra-acinous projections. In some of these projections I have noticed that the intra-elastica connective tissue has become diffusely hypertrophied.

CLINICAL SIGNS

The clinical signs of the diffuse forms of the intra-elastica and extra-elastic changes I have described are those of lumpiness of the breasts in thin people. In fat people they give rise to no definite clinical sign. The lumpiness is due to fat lobules and the underlying breast cannot be palpated. Lumpiness of a breast includes hosts of more important changes, generally summed up in that meaningless diagnosis of "chronic mastitis." The clinical sign, nodularity of a breast, includes early and late carcinomas as possibilities.

The clinical signs of the localized intra-elastica and extra-elastica hyperplasias give rise to a lobulated, defined, solid tumor commonly known as a fibro-adenoma. The tumor may be single in the breast, or it may appear to be single, and microscopic examination reveals unsuspected tumors in its neighborhood, or the tumors may be obvious

clinically as being multiple. The diagnosis from a duct carcinoma in which the tumor is not adherent to the skin is as follows: A duct carcinoma is rounded and not lobulated. There may be a history of a discharge of blood or serum, or both, from the nipple. In its later stages the tumor becomes attached to the skin and there may or may not be enlarged glands in the axilla.

TREATMENT

It will have struck the reader that when all forms of intra-elastica and extra-elastica hyperplasia are localized and form a definite tumor, a segment of the breast is involved, and hence the only rational treatment that can be adopted is to excise the whole of the affected segment that includes the tumor. This statement applies to all forms of fibro-adenomas and it is not safe to attempt only a so-called enucleation of the tumor. I have established the fact that in the formation of fibro-adenomas a segment of the breast is undergoing the change, and thus a cure by an enucleation of the tumor is effected by a pure accident (fig. 11).

The diffuse forms usually require no treatment. When doubt enters the mind of the surgeon, then I believe the safest course is to remove a large part of the gland for the purposes of a diagnosis, which can be made only by making whole sections of the part removed. The importance of a definite diagnosis in glands of this type becomes clear when it is realized that carcinoma may diffusely affect a whole breast and the condition clinically resemble the diffuse fibro-adenomatous states. In my experience such patients have always been lulled into a false sense of security by being sent away with the utterly meaningless diagnosis of "chronic mastitis," a term that I feel sure should be abolished from the nomenclature.

My observations have been based on the results of microscopic examination of whole sections of the breast in which the elastica has been stained.

SUMMARY

1. The changes described in this article occur in the terminal parts of ducts and acini and in tissues that have been normal.

2. Diffuse hyperplasia and the formation of intracanalicular fibro-adenomas occur in the intra-elastica tissue.

3. Diffuse adenomatosis and fibro-adenomas arise from the peri-canalicular and periacinous (extra-elastica) connective tissue. The fibro-adenomas of this type may contain intracanalicular growth which may show diffuse hyperplasia of the intra-elastica connective tissue.

4. The formation of intra-elastica and extra-elastica fibro-adenomas is a progressive process that affects consecutively fresh parts of a segment of the breast that has been normal and accounts for the lobulation of the tumor.

5. The correct treatment of fibro-adenoma is to excise the affected segment of the breast that contains the tumor or tumors.

6. I wish it to be particularly noted that nodularity or lumpiness of a breast can be detected only in thin subjects. In fat people nodularity of the breast is often described, but the nodularity is due to lobules of fat only.

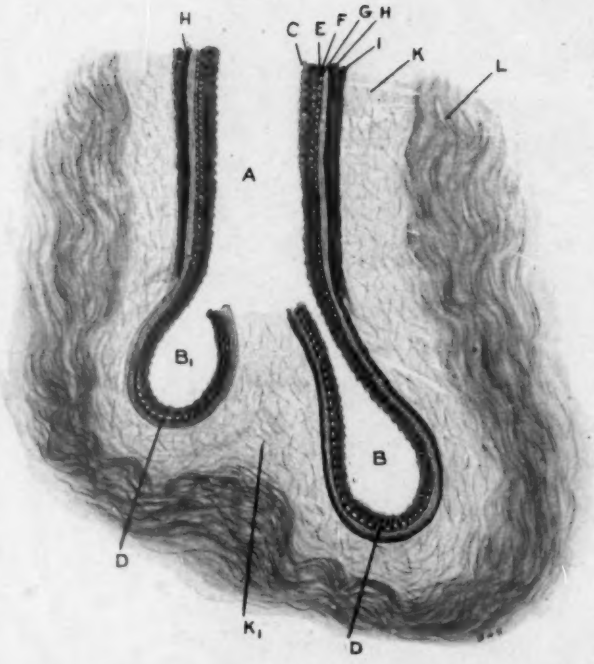

Fig. 1.—Terminal duct and two acini (diagrammatic): *A*, interior of duct; *B* and B_1, interiors of two acini; *C*, lining of epithelial cells. The abrupt change of character that takes place in the epithelium, *D*, of the acini is not shown; *E*, unstriated muscle fiber; *G*, intra-elastica connective tissue; *H*, the elastica; *I*, the muscular tissue of the duct; *K*, the pericanalicular connective tissue; *K*, the intra-acinous connective tissue; *L*, the supporting connective tissue of the breast in which all the foregoing are embedded.

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Fig. 2.—The terminal duct and acini in which is seen diffuse hyperplasia of the intra-elastica connective tissue: *A*, interior of the ducts; *B*, an acinus that has the elastica continued around it; *C*, the elastica; *D*, intra-elastica connective tissue; *E*, the epithelial lining; *F*, acini showing hyperplasia of the intra-elastica tissue with no surrounding elastica. The intra-acinous connective tissue is well shown in this group of acini.

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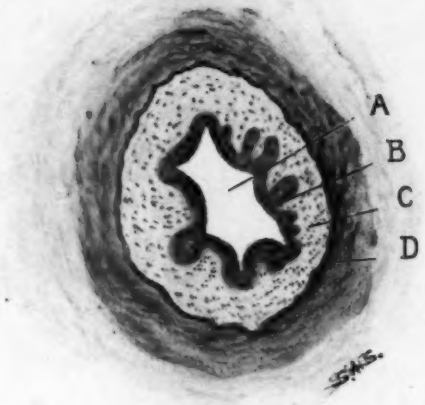

Fig. 3.—Terminal branch of a duct: *A*, the interior of the duct; *B*, its epithelial lining; *C*, the hyperplasia of the intra-elastica connective tissue; *D*, the elastica which itself has undergone a little hyperplasia.

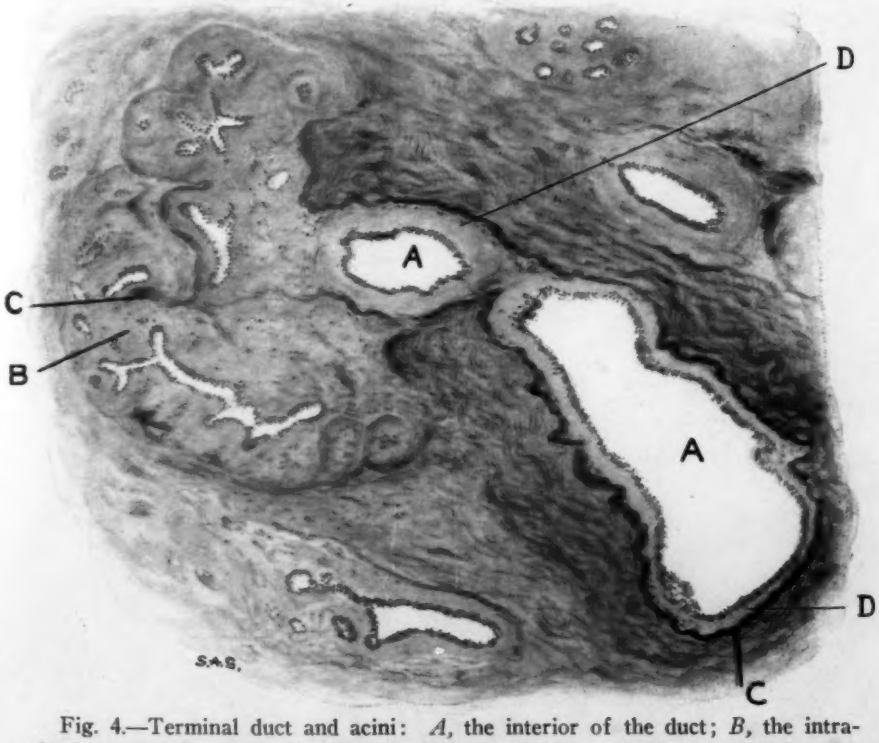

Fig. 4.—Terminal duct and acini: *A*, the interior of the duct; *B*, the intra-elastica connective tissue of the acini which can be traced in direct continuity with the intra-elastica tissue of the duct; *D*, the intra-elastica tissue around these structures has undergone some degeneration; *C*, the elastica which has undergone some hyperplasia.

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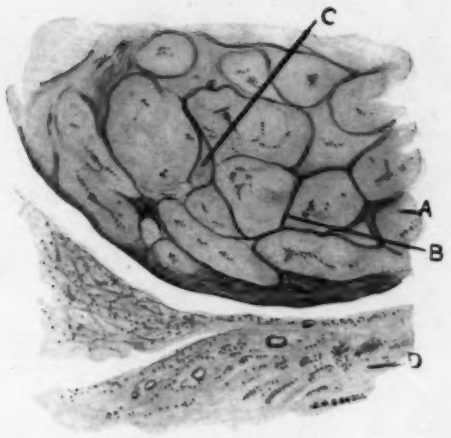

Fig. 5.—Hyperplasia of the intra-elastica tissue surrounding acini which has formed a definite intra-elastica acinous fibro-adenoma; this was discovered accidentally in examining a breast for carcinoma: *A*, the intra-elastica connective tissue which has undergone complete degeneration; *B*, the elastica which surrounds all the acini of this lobule; *C*, the intra-acinous connective tissue, and *D*, surrounding tissue.

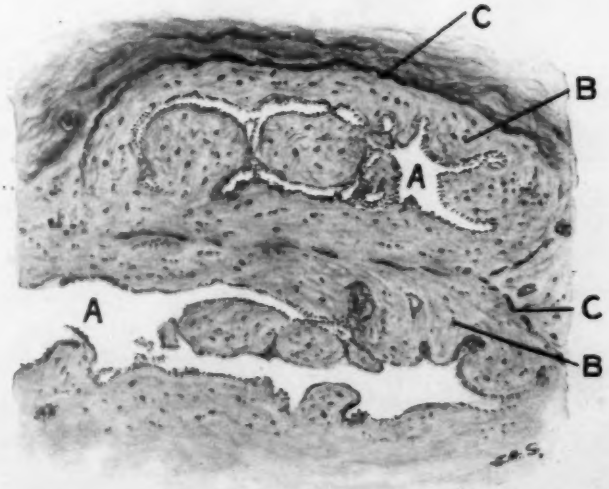

Fig. 6.—Two parts of a convoluted terminal duct which show the beginning of a definite intracanalicular intra-elastica fibro-adenoma: *A*, interior of the duct; *B*, the intra-elastica connective tissue which is forming papillomas lined by epithelium which are growing into the interior of the duct; *C*, the elastica.

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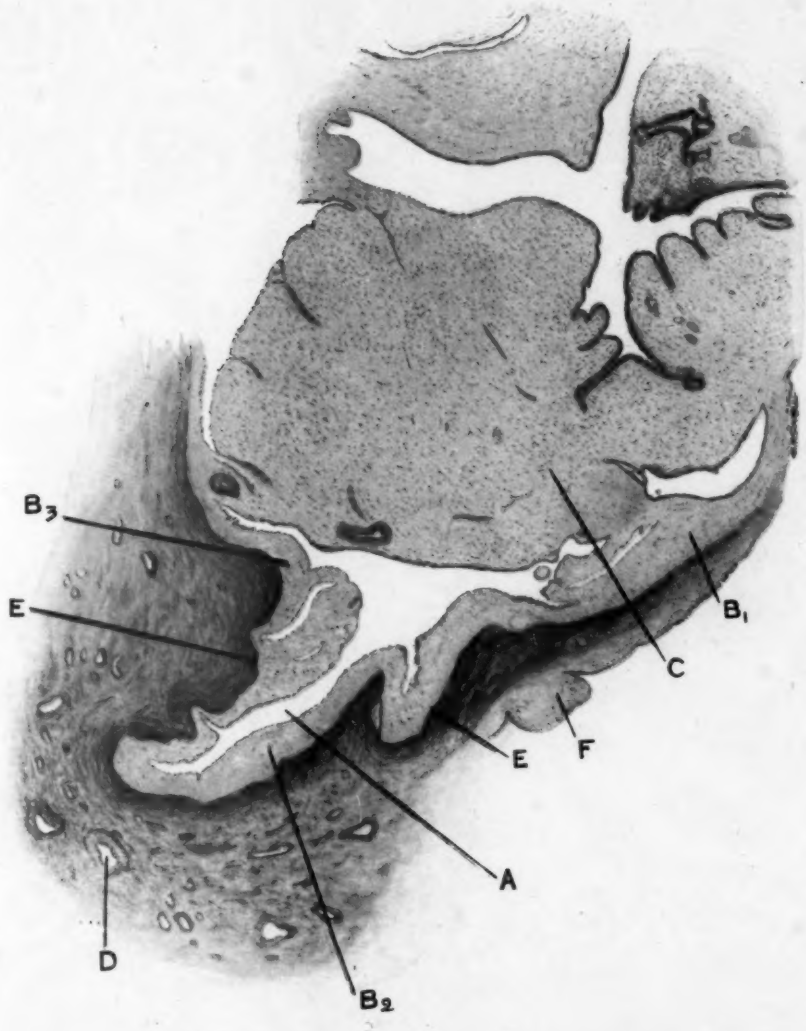

Fig. 7.—Part of an intra-elastica intracanalicular fibro-adenoma, the whole of which was the size of a walnut, from the breast of a married woman, aged 51: *A*, the interior of the terminal duct; B_1, B_2 and B_3, the intra-elastica connective tissue of this terminal duct which has undergone diffuse hyperplasia and from which the fibro-adenoma can be seen growing at *C*; *E*, the elastica; *F*, part of the same tumor in the same duct that was convoluted; *D*, an acinus that has undergone diffuse intra-elastica hyperplasia which has degenerated.

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Fig. 8.—A duct and its acini which has dipped down into the tumor *C* of figure 7 from the epithelial surface lining it; *C*, duct and acini; *A*, a simple epithelial prolongation; *B*, acini without any duct formation.

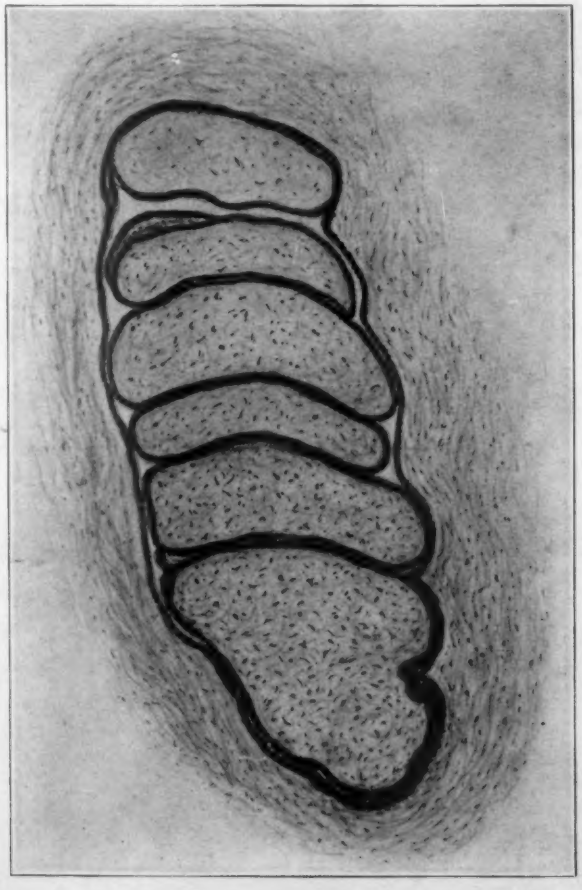

Fig. 9.—The complicated appearance to which the formation of papillomas and secondary papillomas gives rise in this class of tumor.

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Fig. 10.—Diffuse fibro-adenomatosis of the breast: The pericanalicular and intra-acinous connective tissue is seen to have undergone hyperplasia at *B, B, B;* at *A,* the process has resulted in the formation of a microscopic extra-elastica fibro-adenoma.

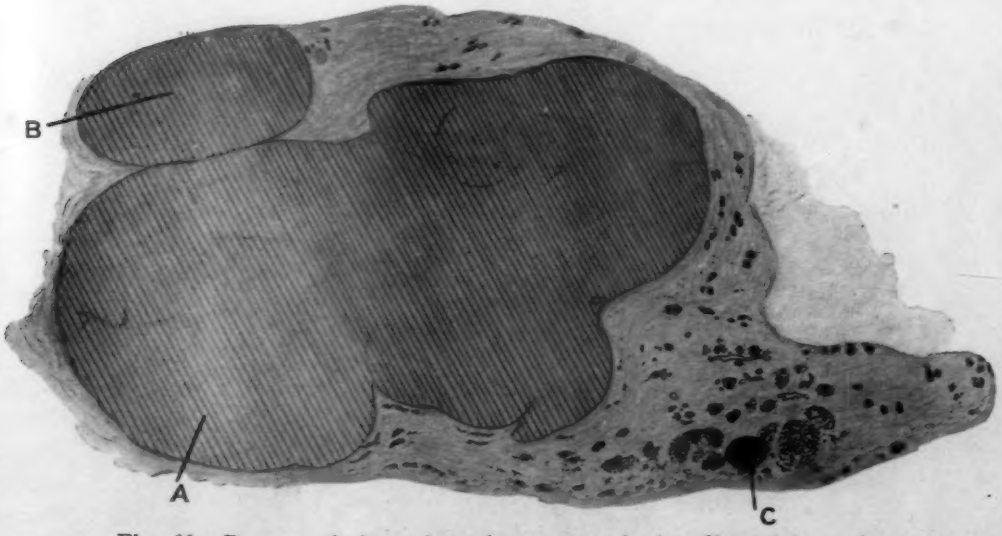

Fig. 11.—Process of formation of an extra-elastica fibro-adenoma in an unmarried woman, aged *27: A,* main tumor of which *B* is a part; *C,* a small extra-elastica fibro-adenoma which is undergoing the process of formation.

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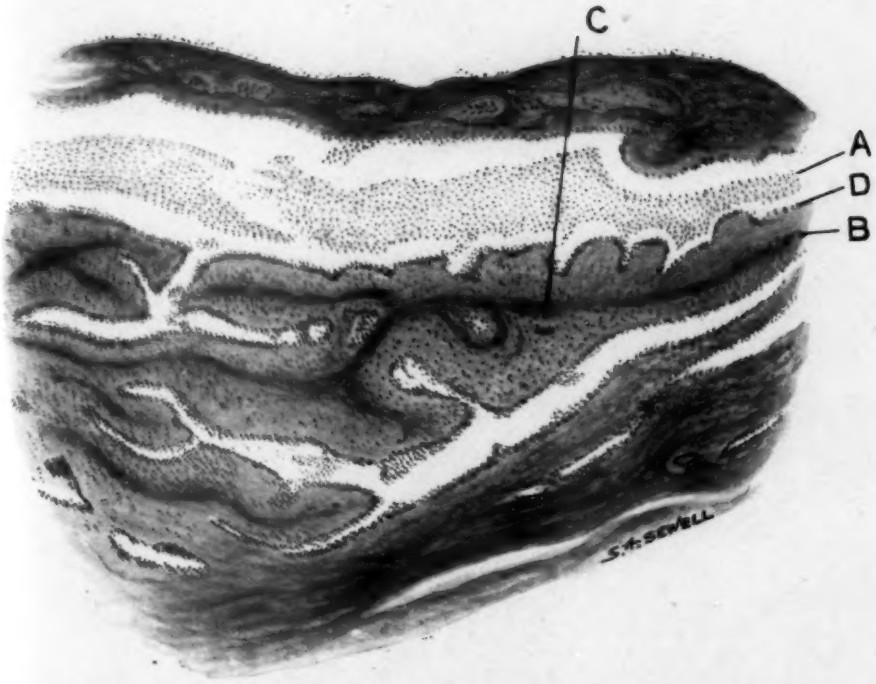

Fig. 12.—Intracanalicular formation within an extra-elastica fibro-adenoma; *C*, its elastica; *B*, the intra-elastica tissue which has undergone hyperplasia; *D*, its lining epithelium, and *A*, the desquamative epithelial hyperplasia that fills the cyst into which the intracanalicular tumor grew.

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THE EFFECT OF THE LIGATION OF THE PULMONARY ARTERY OF ONE LUNG WITHOUT AND WITH RESECTION OF THE PHRENIC NERVE *

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This article will detail late results following ligation of the left pulmonary artery in dogs, without and with simultaneous section of the phrenic nerve.

In a previous report [1] it was shown that the operative procedure is unassociated with any definite shock, that the animals regain normal activity within twenty-four hours and remain so until the experiment is terminated, as much as four months later.

In the interval included in the reported experiments, the lung with intact pulmonary artery expands and herniations in the thinnest areas of the mediastinum occur, but this process becomes stabilized after a month. On the other hand, the lung with ligated pulmonary artery gradually decreases in size, and this process progresses more rapidly when the phrenic nerve has been sectioned. Collateral circulation is established by increase in the caliber of the bronchial artery which doubles its size in three months but somewhat less rapidly when the phrenic nerve has been sectioned.

Microscopically, the alveolar walls become distended shortly after the operative procedure and hemorrhages occur in the alveoli followed by desquamation of the alveolar lining cells and phagocytosis. This in turn is followed by a new connective tissue formation which is more rapid when the phrenic nerve is cut than when the vessel alone is ligated.

The present series of experiments was undertaken to determine the extent of the fibrosis after longer time intervals.

METHODS OF EXPERIMENTATION

The experimental procedure was detailed in the previous report. Seven animals are included in the present series and in three of these the phrenic nerve was cut. The final observation was made two years after the beginning of the experiment. At necropsy the precaution of tying the trachea before opening the chest cavity was constantly observed.

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1. Schlaepfer, Karl: Ligation of the Pulmonary Artery of One Lung With and Without Resection of the Phrenic Nerve, Arch. Surg. **9**:25-94 (July) 1924.

EXPERIMENTAL RESULTS

The results of these experiments are so similar to those included in the former report that the immediate purpose of this article will best be served by a brief summary of the changes in the whole series with special emphasis on the findings in animals at the end of two years after operation.

No deformity of the chest wall or of the spine was evident even after two years' observation. Roentgenograms taken at regular intervals showed the diaphragm at its normal level on both sides when the phrenic nerve was intact, but when it was resected, an elevation of the paralyzed diaphragm was conspicuous and became more and more marked as time passed (fig. 1).

The displacement of the mediastinum and heart was not satisfactorily demonstrated in roentgenograms because it proved impossible to obtain

Fig. 1.—*A*, chest three weeks, *B*, ten months, and *C*, two years after ligation of left pulmonary artery and resection of left phrenic nerve, showing gradual elevation of diaphragm on paralyzed side.

comparable pictures. The data obtained, therefore, are derived solely from necropsies. The lung with the intact pulmonary artery becomes distended and indents the mediastinum in its thinnest portions toward the lung whose pulmonary artery has been ligated. This results in the formation of hernias of the mediastinum, from 3 to 4 cm. deep. By the same process, the right mediastinal lobe becomes interposed between the left lung and the diaphragm. The process becomes stabilized after one month. The enlargement of the lung with intact pulmonary artery is partly due to compensatory emphysema. It is presumed that expansion results in part from a dilatation of the blood vessels in the alveolar walls.[2] There is not enough evidence at hand to indicate whether these

2. Von Basch: Klinische und experimentelle Studien aus dem Laboratorium Prof. von Basch, Berlin **1**:171, 1891.

two factors are effective separately or whether they have any interrelationship.

Excess fluid is not present in the pleural cavity and the pleural covering is thin and glistening everywhere except over the areas of fibrous adhesions, restricted to two well defined areas of trauma at

Fig. 2.—Posterior view of chest organs in dog 140 days after ligation of left pulmonary artery and crushing of left phrenic nerve; the left bronchial artery, *L. Br.*, is more than twice the size of the right one, *R. Br.*, although an intercostal vessel, *I. c.*, branches from the right bronchial artery.

operation: the site of ligation of the pulmonary artery along the mediastinum and the scar of operation in the anterior chest wall. Variations in the extent of adhesion formation are considerable: in a specimen of

one and one-half years' duration, for instance, only a few adhesions were present in the region of the hilum whereas in a specimen of two years' duration, the adhesions to the anterior chest wall and to the mediastinum were quite extensive.

The collateral, nutritive circulation through the bronchial artery is well established within two months after ligation of the pulmonary artery and within three months if the retarding action of the paralyzed

Fig. 3.—Lungs two years after ligation of left pulmonary artery and resection of left phrenic nerve.

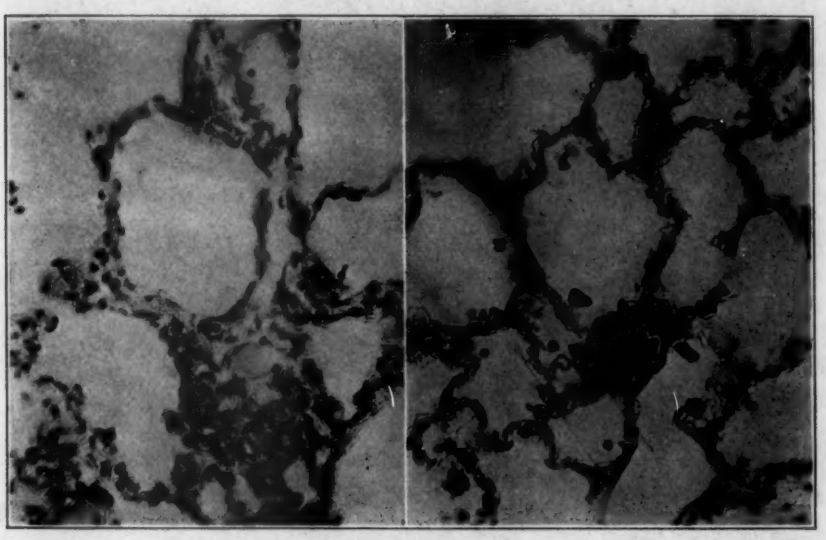
diaphragm is present (fig. 2). The bronchial artery doubles its caliber within this time interval, and in the group without section of the phrenic nerve, is from three to four times the normal size at the end of two years. With a paralyzed diaphragm, the caliber of the bronchial artery generally does not exceed twice the normal even after two years.

Evidence of increased intrapulmonary pressure is forthcoming from the fact that hypertrophy of the right ventricle is encountered in experiments of one and one-half and two years' duration.

The lung with ligated pulmonary artery becomes reduced in size from four-fifths to three-fourths the normal after three months, and thereafter more slowly, reaching two-thirds the normal after two years.

Section of the phrenic nerve hastens this process. Within three weeks it is reduced to three-fourths; in three months to two-thirds; in five months to one-half, and varies after two years between two-thirds and half the original size (fig. 3).

From the beginning the lung with ligated pulmonary artery is firmer than the intact organ and remains so throughout the whole series. The increase in consistency is more marked in the lower lobe and especially if the phrenic nerve has been resected. It progresses slowly in the



A B

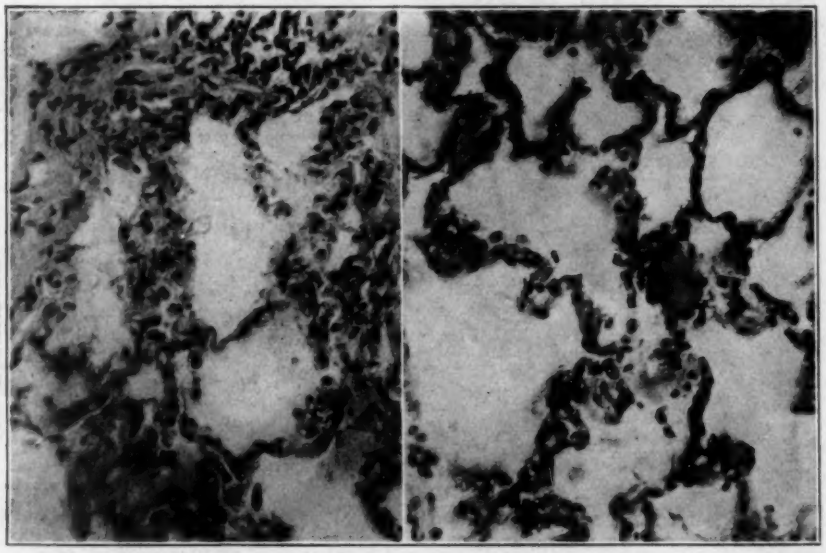
Fig. 4.—*A*, lung whose pulmonary artery was tied two years before; slight increase of connective tissue in alveolar walls and around medium sized blood vessels; *B*, opposite lung, which has a normal appearance; × 375.

course of two years. After two years the difference of the lungs without and with section of the phrenic nerve is striking and justifies a separate description.

The difference between the right and the left lungs when only the pulmonary artery is ligated in the left is not striking. There is a slight increase in consistency of the upper and the lower lobes of the lung with ligated pulmonary artery associated with irregularly distributed, slight fibrosis of the bronchial and the alveolar walls (fig. 4, *A* and *B*).

When ligation of the pulmonary artery is combined with section of the phrenic nerve, the lung becomes mottled by the presence of small, whitish specks visible both on the pleural surface and on section. This change is most conspicuous in the lower lobe and diminishes toward the

apex. Injection of gelatin through the bronchial artery shows that branches of this vessel form the center of these white dots. These in turn are surrounded by air containing zones. Strands of connective tissue are especially numerous in sections through the lower lobe near the paralyzed diaphragm. They cross the field in different directions and separate groups of alveoli with irregularly thickened or almost normal alveolar walls. The walls of the bronchi, too, are thickened (fig. 5 *A*). The intact lung shows dilated, empty alveoli and congested blood vessels irrespective of the length of time of the experiment or the operative procedure (fig. 5 *B*).



A B

Fig. 5.—*A*, the lung whose pulmonary artery was tied and the phrenic nerve cut two years before; marked increase in connective tissue, especially around the larger blood vessels; *B*, opposite, intact lung, which does not show any connective tissue increase; empty alveoli and congested blood vessels are only findings of note; × 375.

COMMENT

Two facts are evident:

1. The collateral circulation is more rapidly and more efficaciously established when the diaphragm is intact.

2. Fibrosis is more extensive when the diaphragm is paralyzed.

The explanation of these facts and their relative importance may be advantageously discussed. The deduction seems permissible that when the pulmonary artery is ligated and the phrenic nerve resected, there is increased stasis which considerably augments fibrosis of the lung. Perhaps the association with elimination of the piston-like action of the

diaphragm which facilitates the blood flow in the lung hampers the formation of an efficacious circulation through the bronchial artery and the pulmonary capillaries.

SUMMARY

1. Ligation of the pulmonary artery is associated with a fairly rapid development of a collateral circulation through the bronchial vessels, but even after two years the extent of the pulmonary fibrosis in the lung whose pulmonary artery is ligated is slight.

2. When ligation of the pulmonary artery is associated with simultaneous resection of the phrenic nerve, fibrosis of the lung is much more extensive, but there is a distinct retardation in the formation of a collateral circulation through the bronchial artery.

These two facts seem to be linked together as the most extensive fibrous reaction occurs about the radicals of the bronchial artery.

3. It is obvious that simple ligation of the pulmonary artery is not an efficacious therapeutic procedure to stimulate fibrosis of the lung in tuberculosis and that more beneficial results might be expected, in case the foregoing experiments are of any value, if ligation of the pulmonary artery is associated with simultaneous resection of the phrenic nerve.

4. A final factor worthy of mention is the evidence of increased intrapulmonary pressure after ligation of the pulmonary artery as expressed by the findings, both gross and microscopic, of right sided cardiac hypertrophy.

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THE SKIN TRIANGLE OF APPENDICITIS

A DISCUSSION OF ITS SIGNIFICANCE AND ITS DIAGNOSTIC VALUE AS OBSERVED IN MORE THAN FOUR HUNDRED CASES OF ACUTE APPENDICITIS *

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NEW YORK

OBJECT OF ARTICLE

The object of this article is to report the value of skin tenderness in the diagnosis of acute appendicitis. The study was conducted in the Third Surgical Division of Bellevue Hospital, service of Dr. George David Stewart, and is based on 428 consecutive cases, over a period of six and one-half years. In a previous article from this division [1] reporting observations on 126 patients, a skin triangle for use in diagnosis was described. At this time proof seemed at hand that skin tenderness limited to the triangle constituted the most important single sign or symptom of acute appendicitis. Such a deduction was too drastic to be reported on the basis of so small a series of cases and it remained for a more extended period of observation to determine the accuracy of this conclusion. The present article constitutes the more extended study.

SIGNIFICANCE OF EARLY WORK

The subject of cutaneous hyperesthesia is not new. Much research and investigation have been concluded in this field, yet scarcely a reference to skin tenderness is found in textbooks dealing with acute appendicitis. It must be concluded either that this work has been largely overlooked or that it has been examined and rejected. A brief historical review is essential to a thorough understanding of the present interpretation of the subject and also makes it clear why there has been little practical use made of these researches.

The Hypothesis of Ross.—It had long been known that remote areas of skin became tender during the course of certain visceral disorders, a classical example being the writings of Hunter,[2] who reported a persistent tenderness of his left arm after an attack of angina pectoris. Yet

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* From the Third Surgical Division of Bellevue Hospital, service of Dr. George David Stewart, and the Department of Experimental Surgery, New York University and Bellevue Hospital Medical College.

1. Livingston, E. M.: The Skin Signs or Viscerosensory Phenomena in Acute Appendicitis, Arch. Surg. **1**:83-95 (July) 1923.

2. MacKenzie, James: Angina Pectoris, Oxford Medical Publications, London, Frowde, Hodder and Stoughton, 1923, p. 53.

Ross was the first to offer a scientific explanation of this occurrence. His interpretation,[3] published in 1888, has become known as the theory of referred pain. Although working at a time when the vegetative nervous system was little understood, he was able to show that nerve fibers pass from the internal organs to the spinal cord and are there associated with sensory nerves coming from the skin. He stated as his belief that this association of fibers within the spinal cord made possible the tender areas of skin already noted.

MacKenzie's Study of Cord Segments.—In 1892 MacKenzie[4] reported his agreement with the "hypothesis of Ross" and cited many cases explained by this theory. He attempted further to define with accuracy the relation between the spinal segments and the skin. By studying cases of herpes zoster and of diseases of the spinal cord MacKenzie was able to map out areas of skin associated with each spinal segment.

Head Zones.—In the same year Head[5] published his first paper on identical lines. Through exhaustive researches he was able to map the entire body and limbs into skin zones, each of which corresponded to the cutaneous distribution of pain fibers from one segment of the spinal cord. Head's name has become attached to the theory of referred pain and the study of cord segments, almost to the exclusion of those of Ross and MacKenzie. The skin areas have become known as Head zones. These zones have been greatly misunderstood. Head stated that such zones were not of equal importance in visceral disease, and that he had seen only certain areas thus involved, while in many others he had never encountered such hyperesthesia from internal disorders.

Head's Maximal Points.—This author carefully pointed out that complete zones were seldom to be found in clinical tests. They are theoretical and are determined only experimentally. He taught that these zones all contain maximal points where the skin tenderness is greatest. When hyperesthesia is present in a zone, it may be found only at the maximal point. At times it occurs over a wider area, but seldom throughout the entire zone. In spite of these teachings, the textbooks of the period soon printed Head's charts and represented each zone as being intimately associated with some internal organ. Each viscus was shown to have a "skin representative" for use in diagnosis, and it was intimated that in a disease of such an organ, hyperesthesia was present neatly distributed over the zone indicated. This undue

3. Ross, James, quoted by MacKenzie (footnote 2, p. 18).

4. MacKenzie, James: Associated Pain of Visceral Disease, M. Chronicle **16**: 295, 1892.

5. Head, Henry: A Disturbance of Sensation, with Special Reference to Pain of Visceral Disease, Brain **16**:1-122, 1892.

enthusiasm caused an almost complete abandonment of the data, and the disregard of Head's emphasis on maximal points and the varying degree of hyperesthesia largely explain the confusion that followed in attempts to utilize these researches for clinical tests.

The extensive work of Head and his predecessors paved the way for all subsequent observations in this field. Yet it is erroneous to speak of a Head zone for appendicitis. This author made no special study of appendicitis and in his final work on pain [6]—though discussing diseases of the heart, aorta, lungs, intestines, gallbladder, kidneys, etc.—he made no mention of the appendix.

Sherren's Work on Appendicitis.—The single outstanding study of cutaneous hyperesthesia in appendicitis is that of Sherren.[7] Though numerous individual cases of appendicitis had been described in which skin tenderness was observed Sherren was the first systematically to test the diagnostic value of this phenomenon through observing a series of consecutive cases. This author described five different areas that might show skin tenderness in acute appendicitis; a small band over the right iliac fossa, a circle about McBurney's point, a triangle in this region, a large lumbar circle, or combinations of these. He stressed no particular area and made no distinction between their respective significance. Some form of skin tenderness was present in forty of 124 cases of acute appendicitis, 32.3 per cent. In regard to the diagnostic importance of skin signs, Sherren wrote, "Cutaneous hyperalgesia may occasionally be of aid in the diagnosis of appendicitis."

Subsequent Studies of Appendicitis.—Ten years later Robinson [8] published an article making a critical review of the work of Sherren. To make conditions similar, he selected the same number of consecutive cases of appendicitis. He found skin signs present in 21.1 per cent of patients. Robinson observed all the shapes of skin involvement previously noted but described two different areas in addition. He concluded that "The prognostic and diagnostic significance of hyperalgesia in appendicitis is slight."

Most recently Cope [9] of Great Britain made a study of skin signs in appendicitis and found such hyperesthesia in 59 per cent of his cases. However, he likewise described tenderness extending over wide areas, and concluded that "increased cutaneous sensibility must not be taken

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6. Head, Henry: Pain, Quain's Medical Dictionary, ed. 3.

7. Sherren: On the Occurrence and Significance of Cutaneous Hyperalgesia in Appendicitis, Lancet **2**:816-821 (Sept. 19) 1903.

8. Robinson: The Clinical Bearing of Cutaneous Tenderness in Various Acute Abdominal Disorders, Especially Appendicitis, Quart. J. Med. **1**:387-416, 1908.

9. Cope, Zachary: Clinical Researches in Acute Abdominal Disease, Oxford Medical Publications, London, Oxford Press, 1925.

by itself to prove the existence of any particular disease" since "various disorders are accompanied by a similar hyperesthesia." Cope, and all previous writers, have approached the subject from a different angle from that of this article. It has been their stated purpose to observe and record all hyperesthesia present in any case later proved one of appendicitis; ours to determine what of this hyperesthesia can be used for diagnosis, to test the utility of a limited area, and to regard as negative all hyperesthesia of wider extent. Former work, then, has described many overlapping skin areas, identical in various disorders and of little practical value.

Twenty years have passed since the publication of Sherren's article. During this period nothing has appeared to alter his conclusions. Since hyperesthesia was believed to be present in so small a percentage of cases, to occur in any of seven different skin areas, and was presented by its investigators as of slight value in the diagnosis of appendicitis, it is small wonder that little reference to the subject is found in current literature.

ADDITIONAL SIGNIFICANCE OF RECENT WORK

The present study assigns an entirely new practical value to cutaneous hyperesthesia in acute appendicitis. This new significance depends on two points of difference from former work; namely, a different method of testing and a different method of localization.

Method of Testing.—Too much emphasis cannot be placed on the necessity of using vigorous tests in eliciting skin signs. This view has not been previously stressed. On the contrary, it was formerly emphasized that vigorous tests should be avoided. The methods previously recommended were the gentle use of a pinpoint or cottonwool dragged across the skin. Sherren stated that "all pressure upon deep structures must be avoided" and advised stroking the skin gently. Robinson wrote, "The best method is to pinch the skin very lightly or to stroke it with a common pin" and that "it is obviously essential that pressure shall be exerted upon no structure other than the skin." These authors found positive skin signs in but 20 to 30 per cent of their cases. Our own tests by similar methods have also shown skin signs to be present in no more than one-fourth of patients with acute appendicitis. Such examinations are totally inadequate. Vigorous tests, on the other hand, show positive hyperesthesia in 86 per cent of cases. It is our experience that the percentage of positive cases is in direct proportion to the grade of stimulus employed.

Traction Test.—We have come to rely almost exclusively on what might be termed the traction method of testing. The skin is picked up between the thumb and forefinger and pulled directly away from the abdomen. A noninvolved area is selected for this initial pull. Traction

is continued outward until the patient signifies discomfort. As a rule a vigorous pull is necessary and is steadily increased until the skin is stretched outward to a marked degree (fig. 1). The amount of force necessary to cause discomfort will vary with different patients. This initial degree of traction is then used as the standard of intensity for that particular patient and uncomfortable pulls of an identical strength are used in all quadrants of the abdomen. In this way any hyperesthetic

Fig. 1.—Traction method of making sensory test, illustrating the adequate stimulus.

area is readily mapped out. The response within the involved zone is that of real pain and leaves no doubt in the mind of either the examiner or the patient that one area differs from all others. It is utilizing strong tests that makes skin signs so objective and apparent and so greatly increases their value.

A pinch test consists of using vigorous twisting pinches on all parts of the abdominal skin, the pinch being of a degree slightly

uncomfortable even on normal skin. The identical stimulus within an involved zone gives rise to an immediate defensive response on the part of the patient, who winces, cries out or reaches for the examining hand. Tests with heat and cold are refinements that may be of aid in defining the limits of hyperesthesia or in demonstrating the complete sensory change within the involved zone.

Localization.—A generalized skin tenderness can have no specific value. Just as a boardlike rigidity of the entire abdomen gives no indication of the site of an intraperitoneal disease, so a generalized hyperesthesia has no localizing value. All viscerosensory phenomena are produced over definite nerve pathways and should theoretically, therefore, be specific and exact. The entire subject has been confusing through a lack of precision as to localization. One of the questions not yet satisfactorily settled is just what organs can produce skin tenderness and which cannot, and to explain this variation. Another is to define the limits of such cutaneous hyperesthesia originating from a single organ. The ideal method of settling these questions would be through direct experimentation. In the case of the ureter this is readily possible. It has previously been demonstrated [10] that the passage of a ureteral catheter, causing an artificial renal colic, produces skin tenderness on the inner side of the thigh. This hyperesthesia can be produced repeatedly and at will and occurs within a single area, the limits of which are constant. Such data are exceedingly convincing.

Appendicostomy Experiment.—Observations on a patient with an appendicostomy gave similar direct experimental evidence with regard to the appendix. A large bougie, passed into the appendix uniformly, set up a colicky pain and gave rise to a sharply localized cutaneous hyperesthesia. The skin tenderness was always maximal at the center of the appendix triangle and never extended beyond its limits. That this single area has a definite relation to disturbances within the appendix has been tested over an extended period of clinical observation.

The Skin Triangle of Appendicitis.—By the appendix triangle (fig. 2) we mean an area bounded as follows: A line from the umbilicus to the highest point on the right iliac crest forms the upper side; a line carried from this point to the right pubic spine forms its lower side, while a line from the right pubic spine to the umbilicus closes the triangle. These lines coincide with no nerve distribution and the triangle is based entirely on clinical observation. Each of its three boundaries marks a border of use in differential diagnosis. Beneath the lower boundary is that definite area involved by renal colic; above its upper boundary a similar area involved in biliary colic, etc.

10. Livingston, E. M.: Further Studies of Viscerosensory Phenomena; Acute Cholelithiasis; Acute Nephrolithiasis, J. A. M. A. **82**:1495-1498 (May 10) 1924.

Skin tenderness in any of these areas begins at a single maximal point, but in certain instances spreads widely over the abdomen. To be utilized for diagnosis, therefore, arbitrary limits must be established; thus, all overlapping and confusion are avoided. The appendix triangle does not signify either the complete or the sole skin area ever involved in cases with appendicitis; it does signify an area of clinical limits, and hyperesthesia confined to these borders is caused, in our experience, by

Fig. 2.—Appendix skin triangle: cutaneous hyperesthesia is of aid in the diagnosis of appendicitis only when it is maximal at the center of this triangle and does not extend beyond its limits.

no other intra-abdominal condition than involvement of the appendix. By "positive skin signs for appendicitis" we refer to hyperesthesia, present on the anterior abdominal wall, confined to the appendix triangle, and maximal at its center.

Contrast with Former Work.—While the present study is based on the clinical importance of a single area, former work described many

areas. The seven appendix regions observed by Sherren and Robinson and the regions described by Cope extended to the right hypochondrium, the lumbar region and even to the left side. This wide variation is due to three factors: 1. Light methods of testing give more varied results. 2. In five of the seven areas the hyperesthesia was centered at McBurney's point and fell within the limits of the present triangle. Yet no mention was made of this uniform central point and each region received equal emphasis. 3. In describing hyperesthesia extending over wide areas and well beyond the limits of the triangle, these authors did not differentiate a simple appendicitis from one with complications, such as general peritonitis, the secondary involvement of other organs, or the concomitant existence of two diseases. All skin tenderness encountered in any case was mapped out as an appendix area.

To avoid confusion it seems essential at this point to note the fact that one of Sherren's five areas was a triangle, the limits of which did not vary greatly from our present skin triangle for appendicitis. That this present triangle was worked out without any knowledge of previous work is a matter of little interest. Yet it insures certain fundamental differences. Sherren's triangle was an actual zone of hyperesthesia and was found by superficial sensory tests; it was present in 10 per cent of cases and one of five areas of equal importance, and was not stressed by any subsequent writer. The present triangle, on the other hand, differs in its boundaries, method of elicitation and significance; it is found in 86 per cent of cases, and by both experimental and clinical proof seems to map out the limits of skin tenderness that signify an uncomplicated appendicitis. Our purpose is not in any way to detract from the classical work of Sherren, yet we believe that to refer to the present area as the Sherren triangle for appendicitis is as erroneous as to refer to a Head zone of appendicitis. Sherren himself neither held nor forecast the present interpretation of the subject, neither did he emphasize a triangle to the exclusion of various other widespread skin fields. We give this matter emphasis only to avoid confusion from a similarity of terminology and location between the two areas.

A fundamental justification for the present appendix triangle is found by reverting to the original work of Head. The entire emphasis of this author was on the existence of maximal points of tenderness and on definite limits. The triangle takes cognizance of these points. The triangle forms a basis for a more exact use of cutaneous hyperesthesia. It necessitates the use of a single area in diagnosis, and considers all skin tenderness extending into this area from without, or extending beyond its limits from within, as negative in the diagnosis of appendicitis.

Bellevue Cases.—This method of testing for cutaneous hyperesthesia and this method of localization have been a routine procedure in the Third Surgical Division of Bellevue Hospital since 1921. It is exceedingly important in the interpretation of results to bear in mind that the findings reported are not those of a single investigator or of a group making a special study. More than sixty different signatures appear on these records, the sensory tests being made by attending surgeons, interns and student clerks, and no single signature is encountered in more than forty cases, while the author's appears in only fourteen instances. The figures, then, represent the practical use of the appendix triangle, and its importance relative to other diagnostic data of appendicitis, as obtained in the routines of a large surgical unit.

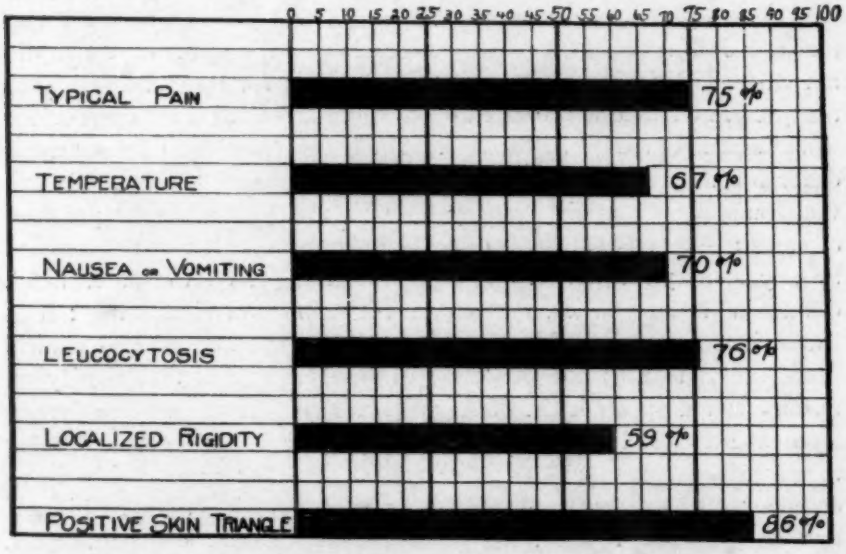

Fig. 3.—Relative frequency of diagnostic data.

Results.—During the 6½ year period covered in this review, March, 1919, to September, 1925, 428 patients with acute appendicitis were admitted to the division. Of these sixty-one are omitted from this report—fourteen had no operations, and the remaining had no tests recorded. In 367 cases with complete preoperative records, the diagnosis of acute appendicitis was confirmed. As in previous publications, a chart has been prepared (fig. 3) showing the relative frequency of the data on which the diagnosis was based. The frequency of each of the classical signs and symptoms in the 367 cases was as follows: typical pain, 286 (75 per cent); nausea or vomiting, 268 (70 per cent): temperature, 246 (67 per cent); localized rigidity, 220 (59 per cent): leukocytosis, 289 (76 per cent). Positive cutaneous hyperesthesia

limited to the appendix triangle was present in 317 instances (86 per cent). In all instances in which the skin signs were negative, a perforative or gangrenous appendicitis was found. Six individual charts, each covering a period of one year, show that the relative frequency of these signs and symptoms remains approximately the same.

These results substantiate all conclusions previously reported from a much smaller number of records. In addition, it is found that this triangle is more frequently present than any other sign or symptom of acute appendicitis.

Certain questions naturally arise in accepting these results: among them, (1) Is this sign pathognomonic of appendicitis, or can it be produced by other conditions? (2) Why is it absent in certain cases of appendicitis? (3) Why should this sign prove to be more reliable than other signs of acute appendicitis?

Not a Pathognomonic Sign.—Positive signs limited to the skin triangle have always, in our experience, signified some involvement of the appendix. This involvement might be classified as follows: (*a*) acute appendicitis; (*b*) appendiceal colic, and (*c*) secondary involvement of the appendix.

Acute Appendicitis.—The conclusion of Sherren that "cutaneous hyperalgesia is probably present at some time during all first attacks of appendicitis" is substantiated by the findings in the present study. Skin tenderness is, however, not always present at a single examination. The hyperesthesia depends on the integrity of certain nerve pathways and destruction of any portion of the nerve mechanism abolishes the sign. Such destruction may be local, focal or central. With necrosis of the appendix the sign disappears (a focal cause): large doses of morphine prior to the examination may mask it (a central cause), and a burn or skin disease within the triangle renders the sign unreliable (a local cause). Barring interruptions of the nerve pathways, cutaneous hyperesthesia is uniformly present during the attack.

The absence of the skin triangle in cases suspected of being acute appendicitis is of almost equal importance. In a previously reported series of sixty operations on patients clinically diagnosed as having acute appendicitis, eleven with negative skin signs (18 per cent) were found to have some other condition such as tubo-ovarian disease, acute nephrolithiasis, pulmonary tuberculosis, etc. Negative skin signs constitute grounds for unusual care. Unless perforation or gangrene of the appendix is present, it is probable that some other disease causes the symptoms.

Appendiceal Colic.—Appendiceal colic will occasionally produce definite localized cutaneous hyperesthesia in patients having no inflammatory condition. A few patients have come under observation, having

abdominal pain and a tender skin triangle but no fever, leukocytosis or other evidence of inflammation. In these cases the symptoms were transient and no operation was performed. It has already been demonstrated by catheterization of the ureter and passing a bougie into an appendicostomy wound that colic without inflammation can produce viscerosensory phenomena. A tender appendix triangle, then, is no criterion for operation and this sign is to be carefully correlated with other diagnostic data.

Secondary Involvement of the Appendix.—In certain instances in which this sign was positive, operation has revealed the primary pathology to be present in some adjacent organ. In all such cases, however, the appendix also was definitely involved. For example, a tubo-ovarian mass with attachment to the appendix may eventually produce skin signs limited to the appendix area. A similar condition might follow the extension into the appendix of an ulcerative enteritis. Neither tubo-ovarian disease alone nor enteritis alone nor any similar condition without simultaneous involvement of the appendix can, according to our experience, produce skin tenderness limited to the area within the appendix triangle described. It seems anatomically possible that other portions of the intestinal tract, having a similar nerve supply, should give rise to skin tenderness and that this hyperesthesia would be limited to the area described, but in commenting on this very possibility Sherren wrote, "I have examined all the cases of abdominal disease which have come under my care at the London Hospital, and have never met with cutaneous hyperalgesia in other diseases of the intestinal tract from the duodenum downward." Our observations have been identical. No case has been observed in which the appendix triangle alone was hyperesthetic yet operation revealed an inflammation of some other abdominal organ, but no appendicitis.

Theoretical Considerations.—We are aware that this sign might theoretically be due to conditions other than appendiceal involvement. For example, a case of herpes zoster of the tenth or eleventh right thoracic roots or a tuberculosis of the spine with pressure on these segments might conceivably be responsible for similar skin tenderness. No such case has come under our observation. The one instance in which it was suspected that such a condition existed was that of a girl having Pott's disease and recent abdominal pain, together with skin signs limited to the appendix triangle (case 276). Operation was delayed twenty-four hours on the assumption that the abdominal signs were due to the spinal disease, yet a subsequent laparotomy revealed a suppurative appendicitis. Were a case of this theoretical type encountered, the complete examination of the patient and the correlation of all data should leave little doubt as to the diagnosis.

In conclusion, it is to be understood that this skin tenderness limited to the appendix triangle does not represent an infallible sign. It may be absent in certain cases with appendicitis (appendiceal perforation), and in certain rare instances it may be present when no inflammation of the appendix exists (appendiceal colic, herpes). To prevent its application in any blind fashion, the factors that render this sign fallible have been stressed at some length. Yet few, indeed, are the instances in which this sign fails to indicate an acute inflammatory condition within the vermiform appendix.

Most Reliable Evidence of Appendicitis.—There seems to be no 100 per cent in physical diagnosis and the importance of various diagnostic methods is relative. On this relative basis our records show that cutaneous hyperesthesia, elicited and localized as here described, deserves a high rating as a diagnostic aid. It is possible, without exceeding the bounds of brevity, to indicate certain reasons why this sign has proved more reliable than any other sign of acute appendicitis.

Pain.—The following in its entirety is quoted from the classic work of Murphy:[11]

> In not a single case is pain absent as an initial symptom. The primary pain with a free appendix is always referred to the epigastrium. The secondary pain is usually not colicky but of the typical inflammatory type and due to periappendiceal involvements. The pain in appendicitis may be referred to the various quadrants of the abdomen, depending on the change in the position of the appendix, either from a congenital or inflammatory malposition. The pain is often referred to the gallbladder region, to the epigastrium, the umbilicus, rectum or chest.

A typical pain, originating at the umbilicus and localizing in the right lower quadrant greatly simplifies the diagnosis of acute appendicitis, yet is present in less than 75 per cent of cases. In the remaining 25 per cent the pain may similate any known abdominal condition and introduces the greatest element of confusion.

In contrast, the tender skin triangle does not vary in location. Being dependent on a nerve pathway settled in embryologic life it is constant without regard to malpositions of the appendix. It is both an early and a late sign. It is present when the pain is still umbilical in location and outlasts all other signs, forming a definite physical finding of greater value than any vague pain history. Being an objective finding it is independent of the language or intelligence of the patient. This skin tenderness was found in all cases except those with gangrene or perforation, being present in 86 per cent of the series.

Abdominal Tenderness.—Of abdominal sensitiveness Murphy writes, "It is circumscribed in the area of the appendix, whether it be

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11. Murphy, J. B.: Surgery of the Appendix Vermiformis, Keen's Surgery, Philadelphia, W. B. Saunders Company, **4**:750, 1908.

McBurney's point, in the subhepatic space, or in the pelvis." This is not to be confused with cutaneous hyperesthesia. The former signifies an early localized peritonitis; the latter a viscerosensory nerve phenomenon devoid of the variations of site characterizing point tenderness.

Nausea and Vomiting.—These were observed in only 70 per cent of cases, actual vomiting in a far lower percentage of cases. As it occurs in most acute abdominal conditions, the value of vomiting as a single sign of appendicitis is slight. As a part of the classical picture of appendicitis, when present, it has considerable value; the absence of vomiting is not even presumptive proof of absence of appendicitis.

Temperature.—Elevated temperature was observed in only 67 per cent of the hospital cases. It varies exceedingly during an attack. In many cases with a retroperitoneal appendix or a fulminating appendicitis it is absent during the entire period of observation. Its presence in typhoid fever, pneumonia, pleurisy, influenza, cholecystitis, salpingitis and other diseases giving acute abdominal symptoms scarcely needs mention.

Leukocytosis.—This is considered by most authors as merely of corroborative value. It was present in 76 per cent of cases. Leukocytic counts are subject to technical error, are often the cause of great delay, and by no means uniformly show elevation. Blood counts have a unique value in determining a suppurative peritonitis following perforation or gangrene of the appendix when pain, skin tenderness, temperature and rigidity may or may not be present. Counts should be made in every case of suspected appendicitis, yet are often not made at the time when most needed. The evidence from skin signs is immediately available at the first bedside examination.

Rigidity.—This sign, being dependent on definite nerve pathways, should theoretically be analogous in value to skin tenderness. To detect an early localized rigidity is, however, an art. Furthermore, rigidity varies with the site of the inflammation; may be absent in some cases of appendicitis, notably the retroperitoneal type, and in the majority of instances, when present, soon becomes generalized, thus losing its value as to localization. Localized rigidity was present in fewer instances than any other classical sign, being observed in 59 per cent of the series. An invaluable index pointing toward a surgical condition within the abdomen, its value as a single sign of appendicitis is inferior to that of cutaneous hyperesthesia, the history, deep tenderness and other diagnostic data.

That cutaneous hyperesthesia limited to the skin triangle was found to be the most valuable single sign of acute appendicitis may be considered due, in part, to its precise localization, explained on embryologic, anatomic and physiologic grounds; to its early occurrence in the course

of the disease; its persistence after other signs have subsided; to the objective nature of the sign; to its experimental proof, through appendicostomy tests, and to its clinical proof through the extended study of an impartial group of observers. The routine use of the skin triangle for appendicitis promises to introduce an element of greater certainty into the diagnosis of this common disease.

CONCLUSIONS

1. Although the study of cutaneous hyperesthesia in appendicitis is not new, skin tenderness has previously been considered of slight use in diagnosis.

2. Recent work assigns an entirely new practical value to skin signs.

3. This is based on (*a*) a new method of testing and (*b*) a new method of localization.

4. Strong grades of stimuli are necessary in eliciting skin signs.

5. The hyperesthesia of use for diagnosis is limited to a skin triangle which has been mapped out through clinical observation and appendicostomy experiments.

6. This sign was present in 86 per cent of over 400 patients with acute appendicitis.

7. In the present study, this sign, of positive cutaneous hyperesthesia limited to the appendix skin triangle, was found to be of more value than any other sign or symptom in the diagnosis of acute appendicitis.

INTRAPELVIC ECTOPIC TESTIS COMBINED WITH ECTOPIA VESICAE, CONGENITAL UMBILICAL HERNIA AND ABNORMAL GALLBLADDER

A RARE CASE *

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A primipara, who reported no unusual history, gave birth to a male infant with extopia vesicae and a large umbilical hernia. The child died on the twenty-seventh day of inanition and bronchopneumonia. At necropsy the infant was markedly wasted, and there was a large tumor extending from the umbilical scar cranially to the epispadic glans penis caudally. The tumor was the size of a grapefruit and in its upper three-quarters was covered with thin skin and distended by coils of intestines. The lower portion of the tumor presented a dark red mass that was the posterior wall of the extroverted bladder from which urine had dribbled continuously. Between the area of thin skin and the area of bladder mucous membrane was a narrow crescentic zone of pinkish epithelium that showed a fine wartlike proliferation and excoriation. The left testis was visible as a subcutaneous swelling in the groin, but there was no trace of the right testis on inspection or palpation; the right scrotal sac was not formed.

A roentgenogram of the cadaver (fig. 1) displayed marked gastroschisis, the two pubic bones being separated by a very wide interval, as the left pubic bone lay anterior to the hip joint and the right pubic bone lay lateral to the right hip joint. Both bones had undergone rotation as well as lateral displacement. The ischia were also separated to a marked extent so as to give a roomy pelvis.

The thorax displayed a marked shrinkage of the thymus gland; the maximum length thereof was 1 cm. and the width 0.5 cm. Extensive areas of bronchopneumonia were seen in the lungs. The heart was normal from the anatomic point of view and the ductus arteriosus was completely closed. The abdomen was opened by an incision along the costal margins and midaxillary lines so that a large flap of abdominal wall could be turned down. The coils of intestine were disposed on either side of a long drawn out mesentery which ran from the great curvature of the stomach to the ringlike opening of the umbilical sac. To the right of this mesentery were arranged coils of ileum and to the left was the colon. The umbilical opening was 4 cm. in diameter and

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was limited on either side by the obliterated umbilical arteries which ran to the umbilical scar at the cranial margin of the umbilical ring. The distended coils of intestine were with difficulty dislodged from the sac, and there was no trace of adhesive peritonitis, but the mesentry was fused with the wall of the sac in the angle formed by the fusion of the umbilical arteries. There was no trace of a Meckel's diverticulum or of vitelline arteries. On careful examination the mesentery above described as extending from the great curvature of the stomach to the sac was seen to be continued along the ascending colon to the cecum and appendix, which occupied the most distal portion of the sac. When this was displaced to the left, the mesentery of the small intestine was seen to be continued within the sac with its contained branches of the superior mesenteric artery. Approximately one half of the ileum and one third of the colon occupied the sac (fig. 2).

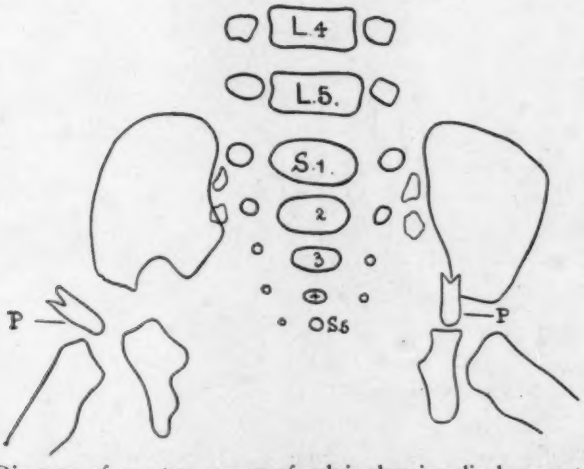

Fig. 1.—Diagram of roentgenogram of pelvis showing displacement and rotation of pubic bones, *P*.

The stomach and pylorus were normal in position but the duodenum was disposed entirely to the right of the middle line. The third part of the duodenum and duodenojejunal flexure were situated anterior to the hilum of the right kidney. The jejunum and the proximal portion of the ileum lay in the right upper quadrant and right lower quadrant of the abdomen, and the distal portion of the ileum was in the hernial sac. The common bile duct held the normal relation to the first part of the duodenum, but entered the posterior aspect of the duodenum at the junction of the first horizontal part with the second vertical part. The gallbladder was abnormal as regards shape, position and attachments. From a normally formed porta hepatis the bile duct ran downward to the point of divergence of the common bile duct and cystic ducts. The

cystic duct passed to the right and then made a hairpin bend whereby the gallbladder was displaced from the normal fossa and occupied a horizontal position behind the falciform ligament with its fundus 2 cm. to the left of the middle line, between the anterior aspect of the stomach and the left lobe of the liver (fig. 2). The terminal portion of the cystic duct and the proximal portion of the gallbladder were attached

Fig. 2.—Dissection of the contents of the abdomen and hernial sac, the neck of which is marked by a circle at *R*.

by a mesentery to the site of the normal fossa for the gallbladder. This fossa had a deep fissure which coursed downward and forward to cut the inferior margin of the liver 2.5 cm. to the right of the falciform ligament. To the right of this fissure was an accessory lobe of the liver which was biconvex in shape and suspended by its margin from the lateral lip of the fissure, no mesentery intervening.

The portion of the colon proximal to the neck of the sac was separated from the pyloric vestibule by a distance of 3 cm. which was bridged across by a "duodenocolic" ligament which had maintained the colic angle in close relationship to the pylorus and first part of the duodenum. From this colic angle the colon passed to the left to form a well marked splenic flexure in relation to the sustentaculum lienis. The descending colon lay anterolateral to the left kidney, and its mesentery was so well developed that a large peritoneal fossa lay between the

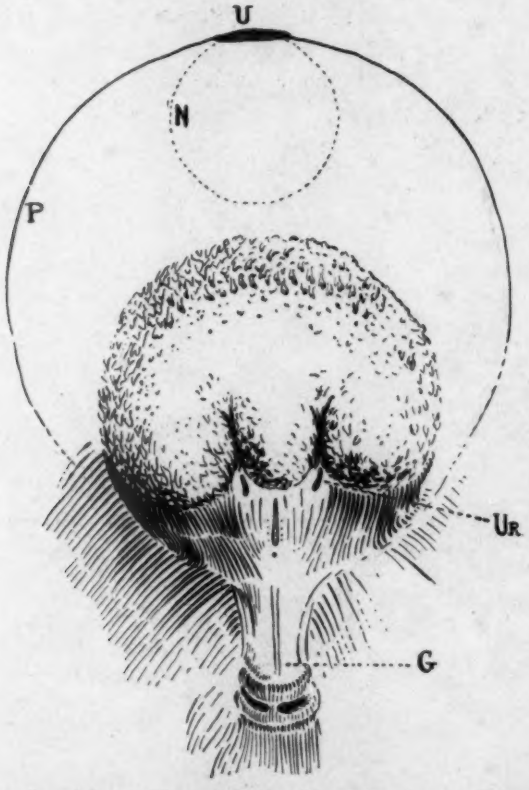

Fig. 3.—Ectopia vesicae: *U*, umbilicus; *N*, neck of sac; *P*, periphery of sac; *Ur*, ureter, and *G*, glans penis with epispadias.

mesocolon and left colic branch of the inferior mesenteric artery anteriorly and the left kidney posteriorly. The sigmoid colon was of average length, had a well marked mesentery, and lay almost entirely in the true pelvis.

The bladder displayed the typical features of ectopia vesicae and epispadias, the openings of the ureters, ejaculatory ducts and prostatic ducts presenting no marked departure from the classical description (fig. 3).

The right testis was situated in the true pelvis at the site of the normal adult ovarian fossa. The testicular vessels coursed downward over the brim of the true pelvis crossing the external iliac artery lateral to the ureter and coming to lie to the inner side thereof—a position closely resembling that of the infundibulo-pelvic ligament in the adult

Fig. 4.—The ectopic intrapelvic testis on the right side; *V. D.*, vas deferens; *V. S.*, seminal vesicles; *U.*, ureter, and *T. V.*, testicular vessels.

female. In the illustration (fig. 4) the testis is raised out of the true pelvis in order to show its attachments. The true caudal pole was superior and lateral and the true cranial pole was medial and inferior. The testicular artery is shown dividing at the true caudal pole. The epididymis was buried in a fold of peritoneum with a considerable

amount of fat, the caput being inferior and the tail superior; the fat formed a well defined lobule around the caput. The vas deferens lay distal and parallel to the ureter and the seminal vesicle touched its fellow in the midline posterior to the extroverted bladder. The gubernaculum was attached to the caudal pole of the testis at a point that lay slightly medial and inferior to the ureter. This point (fig. 4) is displaced somewhat as the testis had to be raised from the true pelvis in order to bring it into view. From the true caudal pole of the testis a fold of peritoneum spread outward and upward into the false pelvis in front of the gubernaculum and lay between the coils of ileum in the right iliac fossa. The gubernaculum entered the internal abdominal ring and its fibers could be traced to the skin of the groin, to the intramuscular connective tissue of the abdominal muscles, but not to the scrotum or perineum.

UMBILICAL HERNIA AND ECTOPIA VESICAE

Frazer and Robbins [1] have described in detail the various phases of the normal physiologic umbilical hernia which appears in the human embryo at the fourth week and persists to about the thirteenth week. About the tenth week they describe the process of rotation of the intestine which gives to the adult human being its typical conformation as a result of the reentrant coils of small intestine returning before the colon and passing to the left beneath the mesenteric vessels and umbilical colon. Several cases of nonrotation and malrotation have been described in detail by Dott,[2] who maintains that 'failure of rotation up to this stage occurs in connection with extroversion of the bladder." The persistence of the colic angle and duodenocolic ligament also characterizes this type of case.

In what manner can the umbilical hernia and ectopia vesicae be correlated? At the beginning of the third month in an embryo of 30 mm. Bryce [3] has shown that the pubic bones are represented by two small nodules of cartilage which lie respectively right and left of the pars urethralis of the urogenital sinus (fig. 5). The pubes are characterized by a late appearance in cartilage, slow growth and a late date of ossification at the sixth month. Parallel to this slow growth and differentiation of the pubic bones we have a late differentiation of the wall of the bladder. The first musculature to appear in the wall of the bladder is the longitudinal muscle which appears toward the end of the second month at the 22.5 mm. stage. This layer is always more distinctly developed on the dorsal aspect than on the ventral aspect and may often be entirely

1. Frazer, J. E., and Robbins, R. H.: On the Factors Concerned in Causing Rotation of the Intestine in Man, J. Anat. & Physiol. **50**:75-110, 1915-1916.

2. Dott, N. M.: Anomalies of Intestinal Rotation, Brit. J. Surg. **11**:251 (Oct.) 1923.

3. Bryce, T. H.: Quain's Anatomy, Embryology **1**:196, 1908.

wanting ventrally, according to Felix.[4] The inner layer of circular musculature appears when the embryo reaches the 26 mm. stage and the internal longitudinal layer, which rapidly assumed an oblique character, does not appear until the 60 mm. stage. This late differentiation of the pubic bones and of the musculature of the bladder is also associated with a late date of formation of the portion of the abdominal wall between the umbilicus and the pubes. The large umbilical opening in the embryo of 20 mm. is of such a size that the two recti are separated by a very wide gap, and the caudal limit of the hernial opening is very near to the cloacal tubercle which is developed into the genital tubercle and phallus. This portion of the anterior abdominal wall is of a short length and lies in a plane that is almost horizontal. At the twelfth week the return of the intestine from the extra-embryonic celom to the abdominal cavity proper, consequent on a relative decrease in the

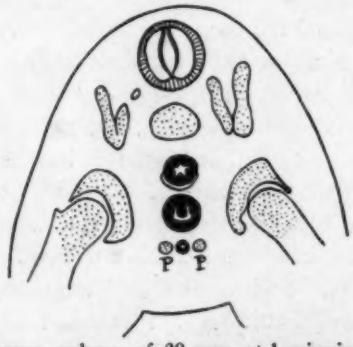

Fig. 5.—Testis of human embryo of 30 mm. at beginning of third month (after T. H. Bryce); the urethra is shown between the pubic cartilages, *P;* posteriorly lie the urogenital sinus and rectum.

rate of growth of the liver,[1] causes a rapid growth in this portion of the anterior abdominal wall and a change in its position from the horizontal to the definitive vertical position. At the same time the recti approach the middle line and rapidly reduce the large opening of the umbilical hernia. The late growth, differentiation and change of position of the lower half of the anterior abdominal wall proceeds very rapidly after the thirteenth week and there are no traces therein of the tendinous lineae transversae which characterize the upper half of the rectus sheath. It is suggested that the delay in the development of the pubes, in the lower half of the anterior abdominal wall and in the musculature of the bladder, is due to the coexistence of the normal physiologic hernia, and that further the return of the intestine to the abdominal cavity is the decisive factor in determining the late but rapid growth and differentiation of these structures.

4. Felix, W.: Keibel an Mall's Embryology **2**:880, 1912.

THE ECTOPIC TESTIS

Since Hunter described the gubernaculum testis it has been held that the ectopic testis could be found wherever the gubernaculum testis obtained a partial attachment. The gubernaculum may be regarded as a four tailed ribbon with attachments to the interstitial connective tissue of the anterolateral abdominal muscles in the neighborhood of the internal abdominal ring, to the subcutaneous tissue of Scarpa's triangle, to the subcutaneous tissue of the perineum and lastly to the scrotum. In each of these situations the testis may be found. An ectopic testis in the true pelvis, as found in this case, is a rare anomaly and it is difficult to account for its atypical position and attachments. Apparently the testis has descended into the true pelvis not only by an actual internal descent but also by a rotation through an angle of 180 degrees about an anterioposterior axis whereby the true caudal pole has remained anchored to the gubernaculum while the true cranial pole and caput epididymis have descended into the true pelvis.

Felix, in his account of the external descent of the testis, after stressing the absence of an internal descent, says that the testis is brought away from the posterior abdominal wall to gain attachment to the anterior abdominal wall by the development of two new structures, and this notwithstanding the increase in the sagittal diameter of the body cavity consequent on the return of the umbilical intestine to the body cavity. The first process to form is the *inguinal crest,* an outgrowth of the anterolateral wall of the abdomen, which grows back as a ridgelike fold in the sagittal plane. The second is the *inguinal fold,* a thick fold of the mesonephros, which is covered with a thickened epithelium and filled with a somewhat more compact mesenchyme. The upper third of the inguinal crest lies opposite the inguinal fold; in this upper third of the inguinal crest a thickening of the mesenchyme develops, and spindle shaped cells appear and form bundles that run in a horizontal direction from the crest toward the integument. The inguinal fold and the upper third of the inguinal crest fuse and thereby the connection between the mesonephric fold and the anterior abdominal wall is accomplished at the 26 mm. stage. Thus the testis is connected with the anterior abdominal wall: (1) by its mesorchium or the epigonal portion of the genital fold; (2) by the plica mesonephridica; (3) by the plica inguinalis, and (4) by the crista inguinalis.

Within this fold is formed, in four distinct parts, a cord of compact spindle shaped cells, the chorda gubernaculi of Hunter. This cord is clearly differentiated before the recti have met in the middle line by the rapid growth of the anterior abdominal wall between the umbilicus and the pubes consequent on the return of the intestine and closure of the umbilical hernia. It is suggested that in the present case, the wide

separation of the pubes, the relatively great width of the pelvis, and the absence of the coils of intestine from the lower part of the abdomen have led to the descent and rotation of the testis.

No case of a true intrapelvic testis comparable to the one described in this baby has been found in the literature, although tumors of undescended testis in the false pelvis have sometimes grown into the true pelvis. Thus a rare exception has been found to what was regarded as one of the fundamental rules of ectopy of the testis, namely, that the testis would be found near the internal abdominal ring or along the course of one of the four tails of the gubernaculum.

THE LIVER AND GALLBLADDER

The fissures of the liver have been described in detail by Thomson,[5] and the occurrence of anomalous fissures and clefts on the under surface of the right lobe of the human adult liver is accounted for by reference to the fetal condition, and by comparison with the arrangement of the lobules in the anthropoids. In the case of fetal livers the fissure for the gallbladder is carried forward so as to cut the anterior margin of the liver in 40 per cent of cases. It is not without interest that this fetal character persists in the gorilla more frequently than in the other anthropoids, the right lobe of the former usually presenting three fissures on its visceral surface. The accessory lobe which characterizes this case (fig. 2) seems to be developed between fissures *b* and *c* of Thomson's classification. The learned account of the morphology and development of the mammalian liver delivered by Bradley [6] has been followed by an accurate account of the accessory lobes of the liver by Cullen.[7] The rare clinical manifestations of liver abnormalities that might require surgical intervention are described in detail by Cullen, who says that the liver is "one of the most stable organs in the body."

In addition to the many factors considered by Bradley and Cullen in the production of accessory lobes must be mentioned the possibility of the liver growing forward into the sac of the normal physiologic umbilical hernia which exists from the fourth week to the end of the third month in the human fetus. Numerous descriptions of the presence of all or part of the liver in the umbilical sac have been given by Ahfeld,[8] and Aschoff,[9] in a detailed account, has described certain cases in which the

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5. Thomson, Arthur: The Morphological Significance of Certain Tissues in the Human Liver, J. Anat. & Physiol. **33**:546, 1898-1899.

6. Bradley, O. C.: A Contribution to the Morphology and Development of the Mammalian Liver, J. Anat. & Physiol. **43**:1, 1908-1909.

7. Cullen, T. S.: Accessory Lobes of the Liver, Arch. Surg. **11**:718 (Nov.) 1925.

8. Ahfield: Lehrbuch d. Geburtsh., 1903, p. 24.

9. Aschoff: Virchows Arch. f. path. Anat. **114**:144, 1896.

liver is not secondarily displaced into the hernial sac, but is situated there from the first. The so-called "adhesion" of the liver to the wall of the sac is not the result of inflammatory action, but is due to the union of the liver with the abdominal wall, and to the fact that the separation of the two has been imperfect. The primitive liver bud grows forward from the junction of the foregut and yolk sac in the ventral mesentery until it fuses with the septum transversum. At a later stage this fusion or "adhesion" has to be broken down so that the liver is freed from the anterior abdominal wall and from the septum transversum anteriorly and superiorly. In this process of fusion and subsequent breaking away, accessory lobes can be formed and in those cases of persistent umbilical hernia in which the liver becomes involved in the hernia the formation of accessory "traction" lobes will be more marked. Those lobes which have the typical arrangement of four vessels, i. e., hepatic artery and vein, portal vein and bile duct, will tend to persist. If the traction produces obliteration of the lumen of any or all of these vessels, then the accessory lobe will atrophy.

The gallbladder is but rarely seen with a mesentery attached thereto in children. In adults, and in the aged in particular, a short mesentery is sometimes seen; very frequently it is the result of the traction of an overdistended gallbladder or of recurrent attacks of local peritonitis. Jacquemet [10] has described this mesentery and its frequency has been given as varying from 5 per cent to 0.5 per cent of cases. From the point of view of comparative anatomy it is interesting to note that no general principle of development has succeeded in correlating the fissures and lobes of the liver, the attachment of the gallbladder with or without a mesentery and the relative size and development of the various parts of the alimentary canal. His,[11] Ingalls,[12] Bradley and Lewis [13] have studied the influence of the omphalomesenteric and umbilical veins in determining the lobulation of the liver. In particular Mall's [14] description of the primitive six lobules of the liver has been studied, but as yet they have not been shown conclusively to be the equivalent of the six lobes of the typical mammalian liver. It is suggested that the normal change over from a primitive liver bud in association with one or both omphalomesenteric veins to the later fetal liver in association with the umbilical veins and later with the left umbilical vein only, together with the changes

10. Jacquemet, M.: Considerations sur les anomalies du foie et des voies biliaires, Thèse de Lyon, 1896.

11. His, W.: Anatomie menschlicher Embryonen **1**:1-84, 1888.

12. Ingalls, N. W.: A Contribution to the Embryology of the Liver and Vascular System in Man, Anat. Record **2**:338-344, 1908.

13. Lewis, F. F.: The Development of the Liver, Keibel and Mall's Embryology **2**:403-428, 1912.

14. Mall, F. P.: A Study of the Structural Unit of the Liver, Am. J. Anat. **5**:227-308, 1906.

taking place in the normal physiologic umbilical hernia, may yield the answer to this puzzling question. In persistent cases of umbilical hernia containing portions of liver the persistence of the omphalomesenteric veins has been described. Serial sections of various embryos are at present being studied from this point of view in order to ascertain if the physiologic umbilical hernia in association with the omphalomesenteric-umbilical complex has any effect thereon.

The abnormal position of the fundus of the gallbladder in the case discussed should be noted as a possible cause of an atypical clinical picture. Now that the cholecystographic method of Graham [15] is being extensively used for lesions of the gallbladder, every atypical position of this viscus has acquired an added interest.

CONCLUSION

This infant presented a combination of anomalies characterized by the absence of those associated deformities of early embryonic life which involved the nervous, skeletal and circulatory systems. It is in such a case that we see the value of the conception of the "space-for-time" division of antenatal pathology which we owe to Jonathan Hutchinson and Ballantyne.[16] The life of this individual seems to have been normal during the embryonic period of the first two months. The anomalies crept in during the neofetal period of the third month, leading to persistent umbilical hernia, ectopia vesicae, ectopia testis and minor irregularities of the liver. This period, the third month, is devoted in particular to the definite establishment of the placental regimen and to the surrender of the vitelline circulation. The frequency of abortion during the third month is a well known clinical fact and a failure of effective placental connections is almost certainly associated therewith. For this reason a plea is made for the routine histologic examination of all placentae from abortions of the third month with a view to eliciting the pathology thereof at a time when the activity of the layer of Langhans and of the syncytium is at a maximum.

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15. Graham, E. A.; Cole, W. H.; Moore, S., and Copher, G. H.: Cholecystography: Oral Administration of Sodium Tetraiodophenolphthalein, J. A. M. A. **85**:953-955 (Sept. 26) 1925.

16. Ballantyne, J. W.: Antenatal Pathology and Hygiene **1**:6, 1902.

THE USE OF FASCIA FOR THE REENFORCEMENT OF RELAXED JOINTS*

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BALTIMORE

RELAXATIONS OF THE KNEE JOINT

During the last few years serious thought has been given to the treatment of relaxed knee joints and many operations have been developed for the reconstruction of the crucial ligaments, most popular of which are those described by Hey Groves, Smith and Gallie. These procedures have been used with success in the type of disability for which they were designed, namely, the extremely relaxed knee joint, resulting from a complete rupture of one or both crucials plus a general relaxation of the capsule. The disability in these cases is so great that the patient is unable to use the member for the ordinary functions of civil life.

In contrast to this type there exists among young, active athletes a type of relaxed knee that performs the normal functions of civil life but which does not permit the individual to participate in active, rugged athletic pursuits. It is this type of disability to which our attention has been directed and to which the described operation is applicable. The common internal derangement of the knee is usually treated with precision. So much has been written on this subject that the medical profession at large is thoroughly familiar with the signs, symptoms and treatment of injury to the semilunar cartilage, loose bodies, etc.

For a number of years the crucial ligament injuries have been stressed, and exhaustive physiologic and anatomic studies have been made with the result that the actual importance of this ligament has, in a way, been overestimated. It has not been so long ago that we were led to believe that a completely severed crucial ligament was irreparable and resulted in a complete disability of the leg. Careful clinical observations and explorations of the knee have shown that the anterior crucial ligament may be completely severed and yet we will still have a fairly stable knee joint, provided the other ligaments, particularly the internal lateral ligament, are intact.

A stretched, attenuated or torn anterior crucial ligament gives a disability that is troublesome to the athlete. It permits an outward rotation of the tibia and an increase in the abduction of the tibia when the leg is in a semiflexed position. It, therefore, explains the pseudo-

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locking (or slipping out) of the knee of which the athlete complains when he attempts to turn suddenly with the leg slightly flexed and the thigh adducted.

The operation I am going to describe is designed to reenforce the capsule of the joint in a way that will help to sustain the leg when it is in this position and is like a substitute for the anterior crucial ligament.

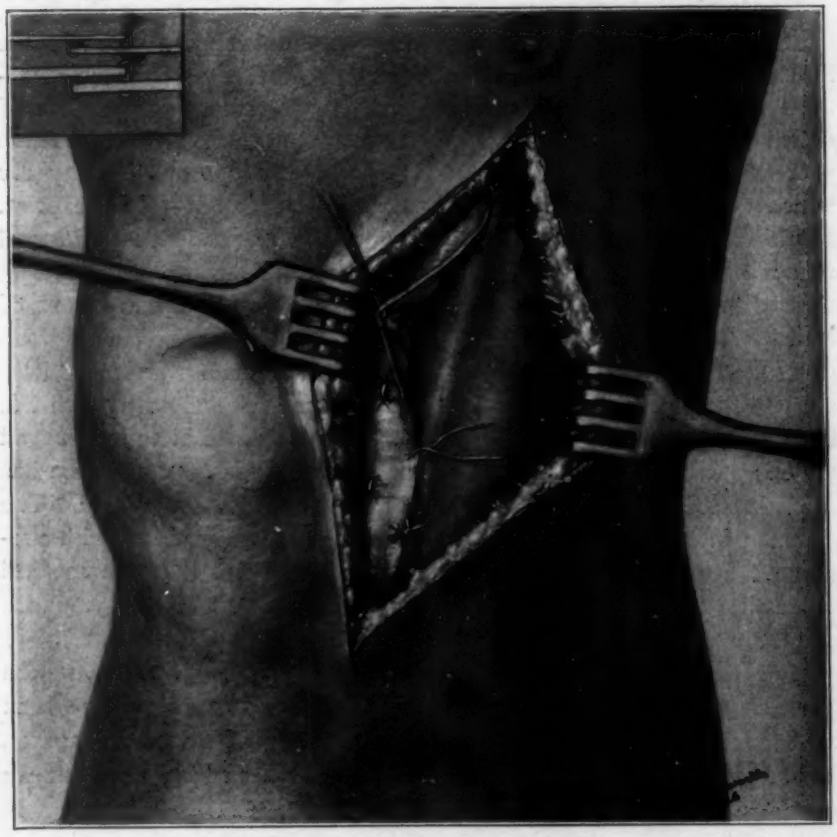

Fig. 1.—Overlapping plication of capsule and fascia.

Briefly stated, the patient gives a history of a major injury of a twisting nature and a total disability for several weeks, following which there is good function and no symptoms except when a sudden strain is put on the leg when it is slightly flexed. The slipping of the knee occurs with an increasing frequency but is not associated with as much disability as with the initial injury. During the last four years we have operated on eight young adults who presented this type of disability. Sufficient time has elapsed in six of the cases to judge the

end-result, the other two being too recent to permit any conclusions. Of the six cases mentioned in this report five have been successful and one a failure.

DESCRIPTION OF OPERATION

An incision is made about three-fourths inch (1.8 cm.) medial to the inner border of the patella, extending downward parallel with the

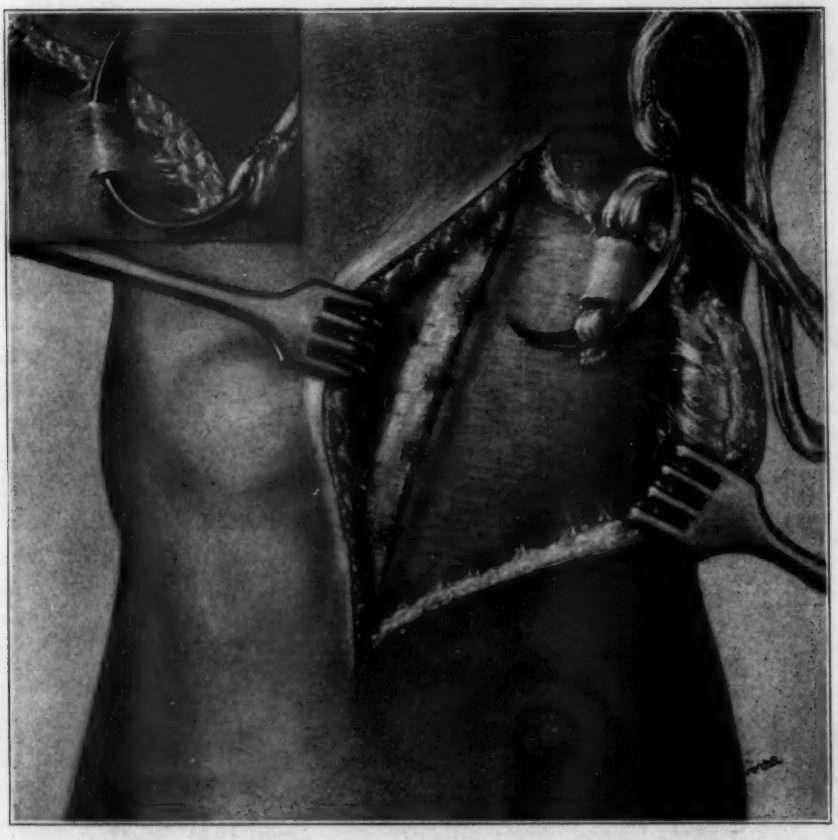

Fig. 2.—Plication completed; first step of fascial reinforcement.

patella tendon. The joint cavity is opened and inspected; any débris or fringes of crucial ligaments are removed; the internal semilunar cartilage is investigated for any possible derangement; closure is made by overlapping the ligamentous structure and drawing the capsule as tightly as mattress sutures will permit. The fascia covering of the capsule is treated by the same overlapping method (figs. 1 and 2). This gives a thick ligament which extends from the inner border of the patella obliquely across the joint. A distinct welt can be felt which seems to persist permanently. In our most recent cases, we have added

strips of fascia to the plication of the capsule reenforcement of the lateral border of the internal lateral ligament, as shown in figure 3. Thus we have reenforced the internal surface of the knee joint in a way that we feel supports the knee when the tibia is in a position of slight abduction and partial flexion. We did not use the patella splitting incision as we wished to use our exploratory incision in the plication.

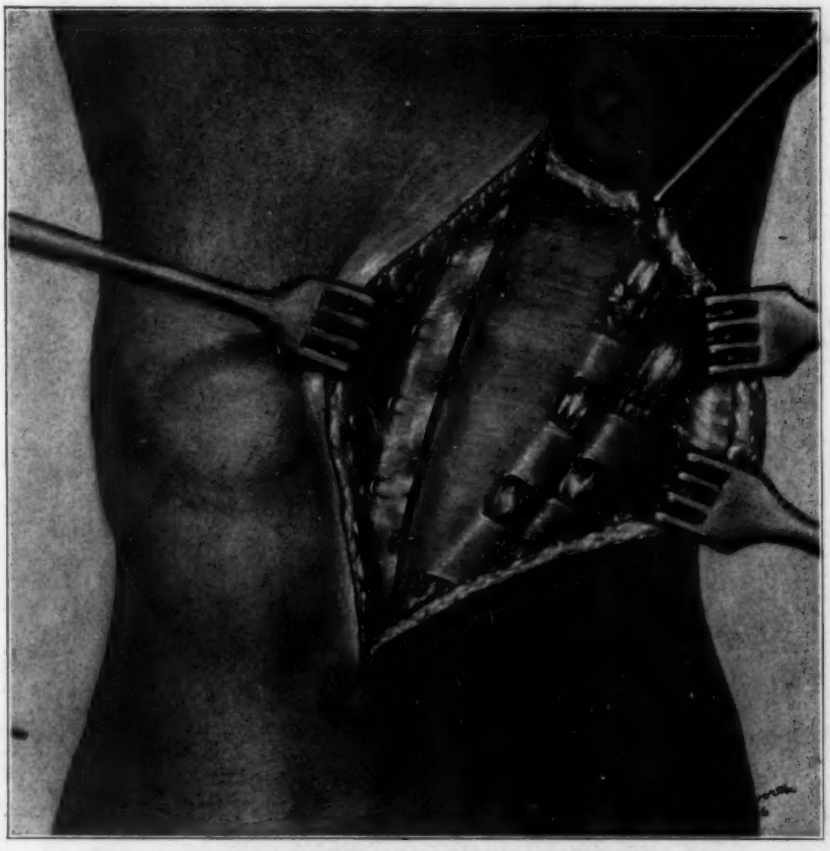

Fig. 3.—Plication and reinforcement completed.

POSTOPERATIVE TREATMENT

From four to six weeks in a plaster-of-paris cast is followed by gradual exercise and development of the quadriceps and the hamstring group of muscles.

REPORT OF CASE

CASE 1.—T. S., a man, aged 26, ten days before examination while playing soccer wrenched the right knee. He was immediately disabled, being unable to extend the knee within 10 degrees of full flexion.

The knee was acutely swollen with an inability to extend it fully. There was no sensitiveness about the internal semilunar cartilage. Exploration of the joint, May 11, 1922, disclosed a torn anterior crucial ligament with frayed pieces wedged between the tibia and the femur, preventing the leg from being fully extended. These were removed. The internal semilunar ligament was normal and therefore was not removed. Closure was made by an overlapping plication of the ligaments and fascia. The leg was immobilized in plaster-of-paris for one month.

In the fall of 1922 this young man was captain of his college soccer team, and was elected a member of the All-American Soccer Team. In 1923 he continued to play soccer and was elected captain of the All-American Soccer Team. There can be no question as to the end-result in this case.

CASE 2.—A. B. S., a man, aged 23, was admitted to the hospital, May 23, 1923. In 1921, while playing football, he suddenly twisted his knee, and this was followed by complete disability. He was unable to continue in football during that year. In 1922 he began to have a continued slipping of the knee joint when attempting to turn or throw any weight on the leg while in a partially flexed or slightly adducted position. As he would express it, his knee would slip out and snap back. There was no locking, but there was considerable pain followed by swelling.

There was no tenderness about the internal semilunar cartilage. There was a moderate relaxation of the knee joint with an ability to slide the tibia forward on the femur. Little increase in lateral motility was noted.

An exploratory operation was performed. The internal semilunar cartilage was normal. The crucial ligament was frayed and stretched, being about one-half its normal size. Several loose pieces of frayed ligament were removed; a plication of the capsule closure was made.

This young man was captain of his college football team and played throughout the entire season of 1923 with no inconvenience so far as his knee was concerned. There can be no question as to the end-result of a functional return in this case.

CASE 3.—J. W., a man, aged 20, was first seen Nov. 8, 1923, giving a history of having sustained a twisting injury to his knee eight months before. This was followed by complete disability, which lasted for about three weeks. After that time he was greatly inconvenienced by the knee slipping when the leg would be in a position of partial flexion and the tibia abducted on the femur. He never had any locking. He was admitted to the hospital, Nov. 11, 1923, and an exploratory incision was made. There was a torn anterior crucial ligament; frayed sections were removed. The internal semilunar cartilage was normal. A plication closure was made. The leg was immobilized in a cast for six weeks following the operation.

We were unable to get a report from this patient at the present time. However, one year after the operation he was able to indulge in athletic exercise and could play basket-ball without any discomfort.

CASE 4.—W. E. M., a man, aged 21, was first seen July 24, 1923, giving a history of having sustained a twisting injury to his knee in 1920. This was followed by complete disability for several weeks. He was unable to play basket-ball or baseball. He had had continuous trouble of pseudolocking of the knee after that time. Physical examination showed an ability to slide the tibia forward on the femur. An exploratory operation was performed on the knee, Jan. 29, 1924. The anterior crucial ligament was torn. The internal semilunar cartilage was normal, and was not removed. Plication and reenforcement of the lateral ligament were done. The leg was in a plaster cast until March 6, 1925.

The patient reports that last winter he played eighteen games of basket-ball with absolutely no inconvenience to the knee. He is also able to engage in active, rugged exercise, such as baseball.

CASE 5.—B. H. M., a boy, aged 17 years, was first seen Nov. 8, 1924, giving a history of having sustained an injury to his knee two weeks before. Examination showed considerable synovitis with an increase in fluid, tenderness about the internal lateral ligament and marked relaxation of the knee joint. There was a great deal of pain on movement. The leg was immobilized in a position of 15 degrees short of full flexion for a period of four weeks. Following this a knee cage was applied and was used for several months. March 20, 1925, the patient reported that he was unable to engage in athletics, even with the use of the knee cage. Exploration, March 22, 1925, showed a complete rupture of the anterior crucial ligament with a very movable semilunar cartilage. The cartilage and frayed pieces of crucial ligament were removed. The capsule was plicated. The leg was immobilized for a period of four weeks following operation, after which the knee cage was reapplied.

This young man has been unable to engage in his favorite sport of football as the knee still continues to give him trouble. It is interesting to note that this was the case in which the cartilage was removed, and is the only case in which we failed to get a perfectly satisfactory result.

CASE 6.—T. T., a man, aged 21, was first seen after a football injury in the fall of 1921, having sustained a severe wrench of the knee associated with swelling and complete disability. Diagnosis of a torn crucial ligament was made and suitable immobilization was instituted for a period of six weeks, following which a knee cage was applied. With the use of the knee cage the patient was able to play football during the following season. Since that time he had had an increasing disability and slipping of the knee so that he was unable to indulge in any rugged athletics or do the ordinary things of civil life without inconvenience.

Physical examination showed that the patient had an ability to slide the tibia forward on the femur, and a considerable amount of lateral mobility of the knee. An exploratory operation was performed on the knee, June 9, 1925, which showed the anterior crucial ligament to be frayed and relaxed. The cartilage was normal. Plication of the capsule and reinforcement with fascia were done.

The patient reported, April 12, 1926, that he was able to run, play baseball, and was in training as a member of his crew at his university. During the last year he was also able to do fancy dancing without any

inconvenience. There is no evidence of any relaxation of the knee joint at the present time.

We believe that the six cases that we have reported have been done over a sufficient period of time to allow us to judge the end-results, five of the six having been unqualified successes, what seems to be a perfectly normal knee being restored to the athlete. I feel that the procedure is a satisfactory one in well selected cases. I do not advocate the use of this operation until all conservative treatment has failed.

I have also found strips of fascia useful in the repair of radio-ulnar relaxations and recurrent dislocations of the sternoclavicular articulation. The objection to the use of fascia in the latter case is that it produces quite a marked deformity from the mass of soft material and is, therefore, not advisable in female patients in whom personal appearance is to be considered.

RECURRENT DISLOCATION OF THE SHOULDER

There is perhaps no common joint disability that has to its credit more types of operations for its cure than recurrent dislocation of the shoulder. One naturally concludes that the ideal operation has not been described or there would be no need for so many surgical procedures: muscleplasties, capsulorraphies, bone grafts and fascial transplants. It is not my desire to review the volumes of literature and truly constructive work that has been done on this subject, but to cast my lot with those who feel that the solution of a cure for recurrent dislocation of the shoulder will probably be found in the properly placed check ligament between the scapula and the humerus.

It is interesting to note that there has been a constantly increasing tendency of surgeons to resort to this type of procedure, Joseph, Rich, Gibson, Loeffler, Plummer, Potts, Wülfing and Hoke all reporting successful cases. The operations done by these men vary from the fixing of the head and tuberosity of the humerus to the acromion process by bands of fascia to fixing the anterior capsule to the acromion process by the same material. The principle of the latter procedure is to give a check ligament that will prevent the head of the humerus from sliding forward when the arm is in abduction and displaced slightly backward.

The operation we describe is essentially the same as that described by Plummer and Potts, having to our fancy two additional advantages. First, it shortens the relaxed capsule, and, second, we think it is a more simplified technic.

DESCRIPTION OF OPERATION

The shoulder joint is approached through the anterior incision extending from the acromion process downward, separating the fibers of the deltoid and exposing the anterior and inferior part of the capsule. The tendon of the long head of the biceps is identified and acts as a

guide to the line of fascial sutures. A strip of fascia is taken from the tensor fascia femoris and fixed to the Gallie type of needle, according to technic described by him. The arm is externally rotated to permit suturing as far forward as possible, and the fascia is laced into the capsule, as shown in figure 4. The capsule is then drawn taut, as shown in figure 5, and the lacing fixed firmly to the capsule by chromic catgut sutures. The fascia is then passed through the tip of the

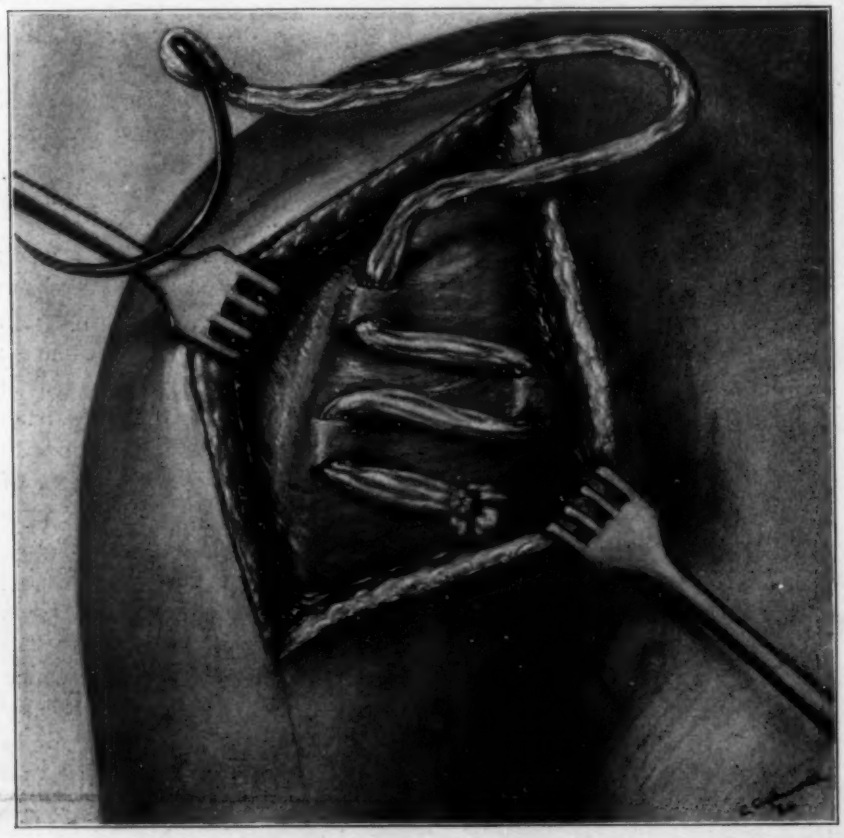

Fig. 4.—Fascia laced into relaxed capsule.

acromion process, either by a needle or by drilling a hole through the process, fixed at this point and again reattached to the anterior part of the capsule. Usually it is brought to a lower position than is shown in the accompanying illustration.

By this transplant and suture we have taken a slack from the anterior capsule and established a ligament extending from the acromion to the anterior capsule. The subscapular tendon may be included. We

believe that a ligament in this position reenforces the capsule in a way that prevents an anterior dislocation of the shoulder.

The arm is immobilized in a Velpeau type of bandage for a period of four weeks, after which gradual use is begun.

CASE 7.—W. O., a man, aged 20, approximately six months before examination dislocated his shoulder. He continued to play football during that season with the arm fixed to the side by an apparatus. In spite of this he had several

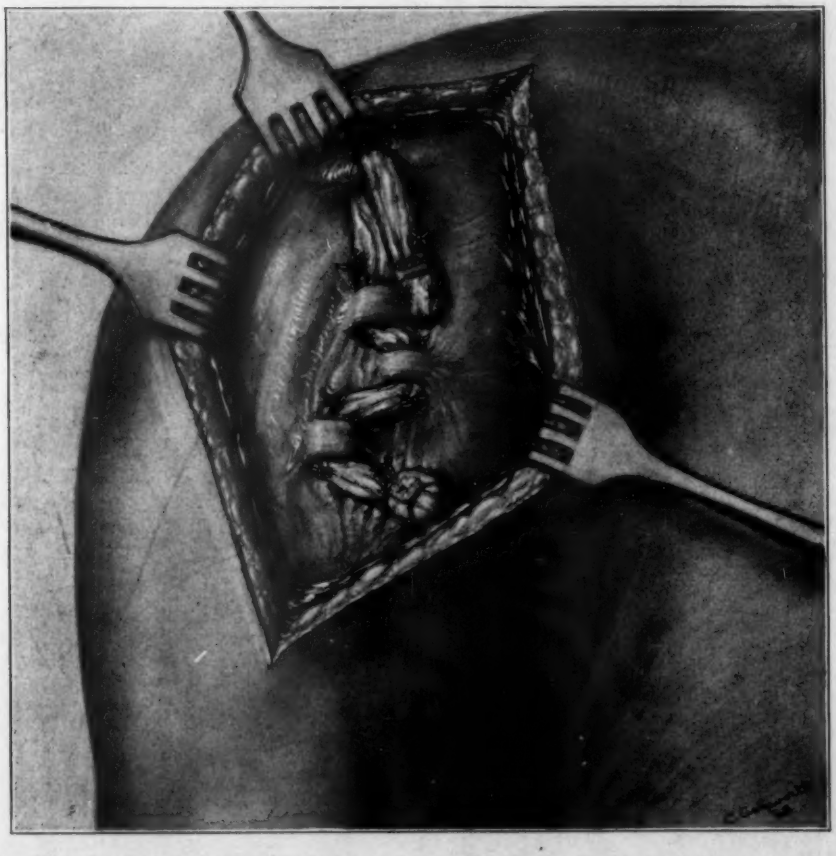

Fig. 5.—Relaxed capsule drawn taut and fixed; fascia inserted into acromion and reattached to capsule.

dislocations and was unable to indulge in any athletic sports that required the use of the arm. He presented a typical history and clinical picture of a recurrent anterior dislocation of the shoulder.

The operation described above was performed, Feb. 20, 1925, and the arm was immobilized in a Velpeau bandage for four weeks. Gradually exercise was taken. During the season of 1925 he played football on his college team without apparatus, having no difficulty with the shoulder. At present he states that he does not realize that he ever had any trouble with his shoulder.

Case 8.—A. H., a man, aged 23, for a period of several years had had a recurrent dislocation of the shoulder which had been operated on unsuccessfully. He was unable to indulge in any athletic sports. An operation was performed, June 24, 1925, and the arm was immobilized in a Velpeau bandage for four weeks after operation. During the sixth week of convalescence the patient fell aboard ship and the arm was forced into a position of hyperabduction. He had some local discomfort in the shoulder but no dislocation. The arm remained sensitive for a period of ten days following the accident. He now uses the arm constantly, engaging in active athletic exercise, such as boxing, without any discomfort.

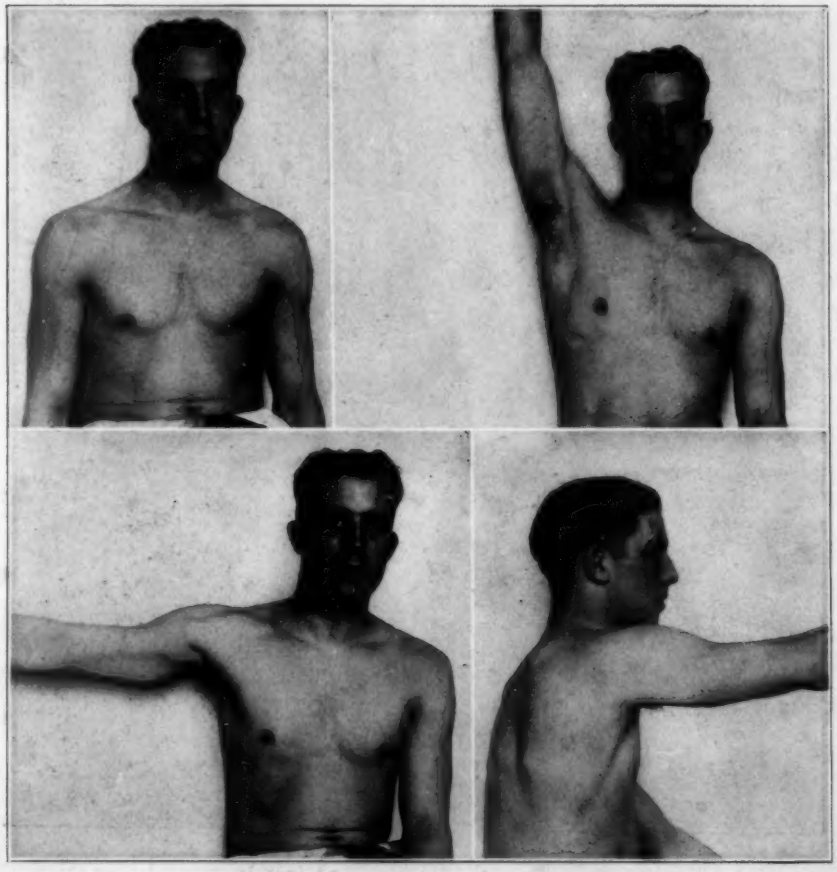

Fig. 6.—Result of operation.

Case 9.—F. C. I., a boy, aged 13 years, for the last three or four years was able voluntarily to dislocate the shoulder anteriorly and partially luxate it posteriorly. He had been unable to indulge in any exercise that required the use of the arm, such as throwing a baseball, as the shoulder would involuntarily dislocate anteriorly.

Examination showed a marked relaxation of the capsule with the ability to dislocate anteriorly the shoulder and produce a partial posterior dislocation. With the patient relaxed we were able to pull the head of the humerus to the

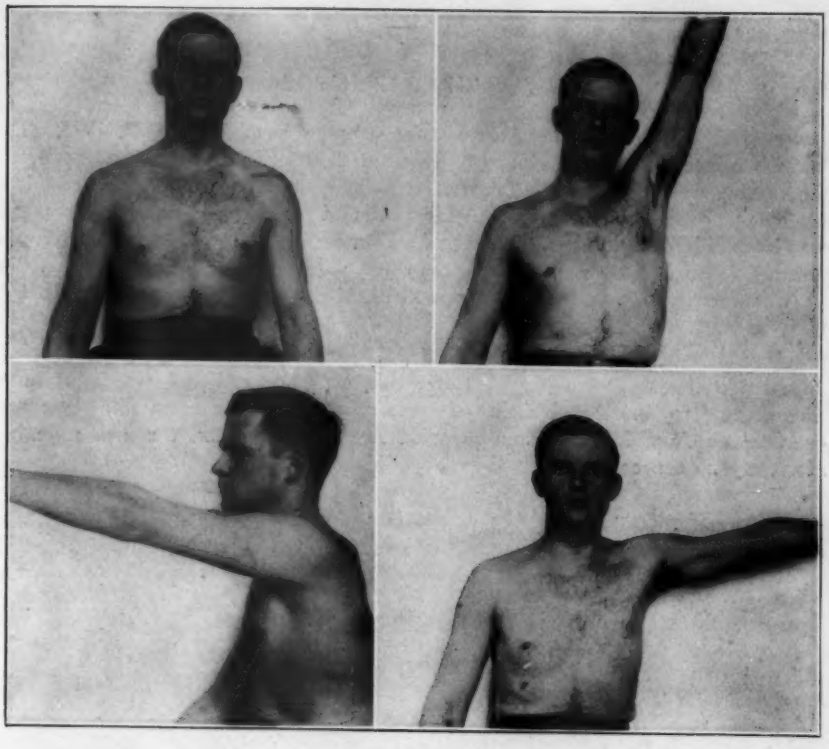

Fig. 7.—Result of operation.

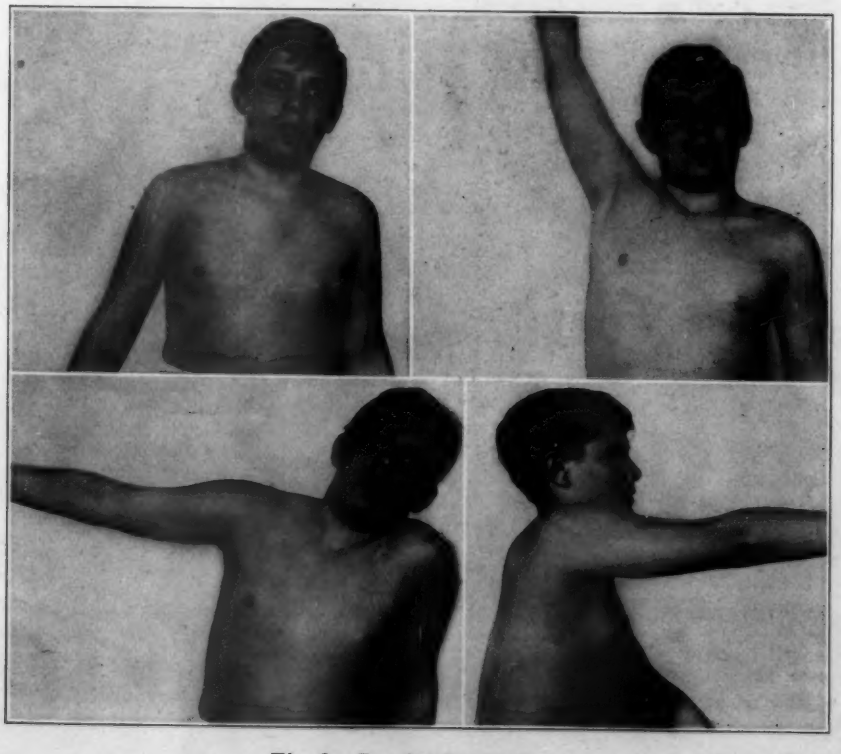

Fig. 8.—Result of operation.

lower level of the glenoid. An operation was performed, June 24, 1925. The horseshoe incision was made directly over the shoulder, the deltoid was retracted, the capsule was reinforced anteriorly, fascia being carried through the acromion; a similar procedure was applied to the posterior part of the capsule. The arm was immobilized in a Velpeau bandage for four weeks, followed by active exercise. April 2, 1926, the patient reported that he felt no discomfort in the shoulder, that he was engaging in active athletics, and could for the first time play baseball with boys of his age.

CASE 10.—M. W., a woman, aged 21, June 6, 1924, dislocated her right shoulder while pushing a piano. Since that time she had had six dislocations. She became so apprehensive that she scarcely used the arm at all. She was operated on Aug. 28, 1925, and reported April 2, 1926, that the arm gave her absolutely no concern.

UTILIZATION OF SKIN-MUSCLE PEDICLED FLAP IN OPERATION FOR LUNG ABSCESS

PRELIMINARY REPORT *

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In the descriptions that follow it will be easy to perceive the influence of Schede and Estlander, of Lockwood, Keller and Graham, for there is nothing new in large square or oval flaps when operating on the thoracic cavity, nor is there anything new in leaving skin edges unsutured after operations on infected areas. However, in the literature dealing with lung abscess, there have been discovered no references to the purposeful creation of a large skin-muscle pedicled flap, with the predetermined intent of suturing it to the chest wall, wide open, muscle side exposed, once the abscess cavity has been fairly opened, and so leaving it for four or five weeks, until secondary suture can be safely carried out. Such a procedure has given satisfactory results in a small series of cases, and therefore a preliminary report is now submitted.

Operation for lung abscess is far from being standardized. It is conceivable that never will it be fully standardized. There are many factors that make it a difficult subject to reduce to simple, definite statements. Even before electing a surgical policy the relative merits of postural drainage and of bronchoscopic treatment must be weighed. If surgery is decided on a host of variables is at once introduced. The anatomy of the anterior chest wall differs from that of the posterior chest wall. The approach to apex differs from the approach to base. The accessibility of the axilla is easy and the accessibility of the mediastinum is difficult. Fistulas are a source of trouble in one case and a safety device in another case. One abscess is at the periphery and another is deep within the substance of a lobe.

One of the greatest obstacles in the surgical care of lung abscess is inadequate access to the diseased tissue. The operative wound is, as a rule, too small to permit the complete mastery over the situation that must be exercised if the best results are to be attained. Furthermore, whatever is done under direct visual control is better done than that which is governed by blind touch. Throughout modern literature on lung abscess there is a decided trend in favor of greater accuracy of approach and more elaborate treatment of the lung tissue, even at the

* From the surgical service, Robert Packer Hospital.
* Read before the New York Society for Thoracic Surgery, March 23, 1926.

expense of anatomic structures. The creation of a large opening in the chest wall helps to offset the difficulties that have just been mentioned.

Gradually, at the Robert Packer Hospital (Guthrie Clinic), a more and more radical operative policy has been employed in cases of lung abscess submitted to surgical treatment. Adequate access and constant

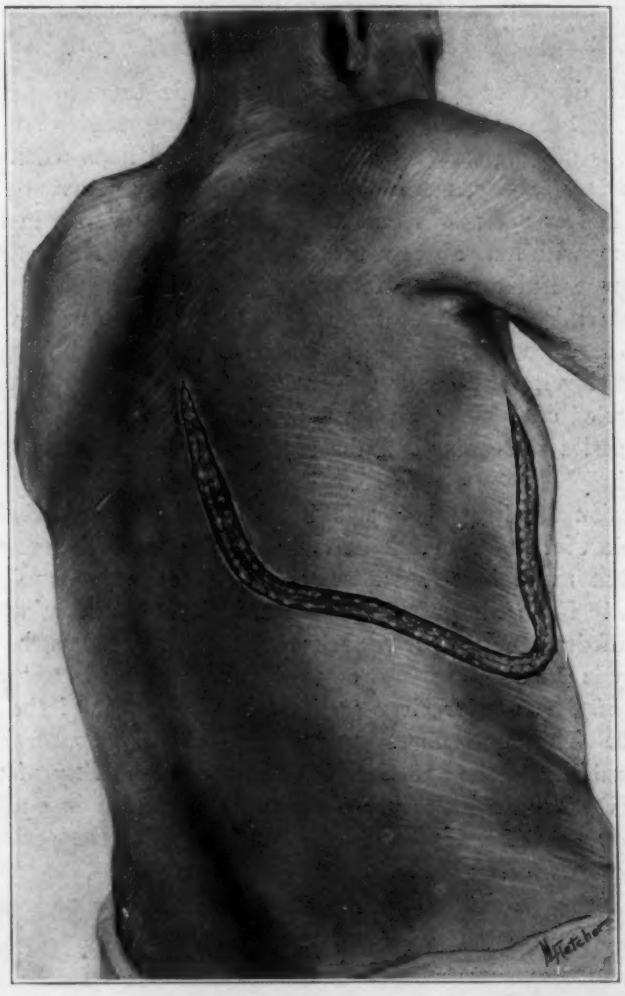

Fig. 1 (stage 1).—Preliminary incision showing relatively large size of flap; in this case the vascular hinge is at the superior border of the flap; it might equally well be placed at the posterior border.

visual control are the dominant concepts. The open flap and a radical attack on the chest wall are the tactical expressions of the determined strategy. Such an operation is best divided into stages. The history of the flap can be clearly traced through the several stages.

STAGES OF OPERATION

Stage 1.—The location and extent of diseased tissue is determined as accurately as possible by physical examination and roentgenograms. Aspiration is preferably omitted. It is a questionable procedure in cases of lung abscess. If pleural adhesions are present, little harm can be done. If adhesions are not present, there is serious risk of soiling the pleural cavity. The outlines of the flap are marked on the skin, roughly square, one side to remain as hinge and source of blood supply, the other three sides to be incised freely to the chest wall proper. Such

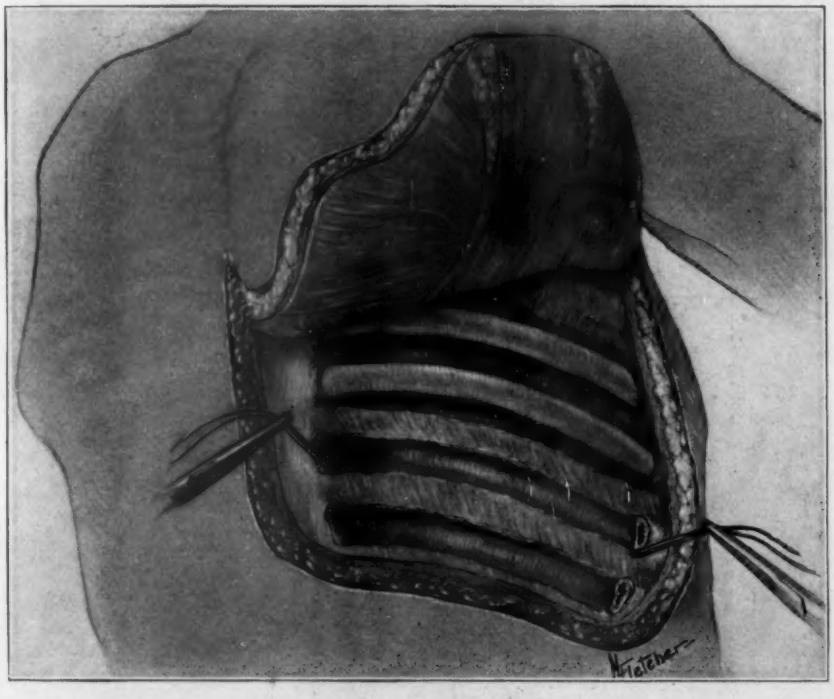

Fig. 2 (stage 1).—Flap turned up showing fibers of serratus and latissimus dorsi; ribs exposed and lower two resected.

a flap can best be utilized in the lower half of the chest; it is not so convenient for upper lobe approach, either anteriorly or posteriorly. The flap is laid wide open, immediately exposing the ribs and the intercostal structures. Subperiosteal resection of the exposed ribs, as many as may be necessary, is accomplished. The intercostal arteries, nerves and veins are ligated en masse at each rib stump. Through each periosteal sheath a small incision is made leading into the pleural cavity, and a finger tip is introduced to determine the presence or absence of adhesions. If no adhesions exist the lung is sutured to the

chest wall. Due care is exercised to prevent open pneumothorax—small exploratory incisions, gauze tampons, differential pressure. Ordinarily stage 1 ends at this point and the flap is replaced in its anatomic position and tacked down, muscle to muscle, skin to skin. Drainage may or may not be introduced beneath the flap. If adhesions

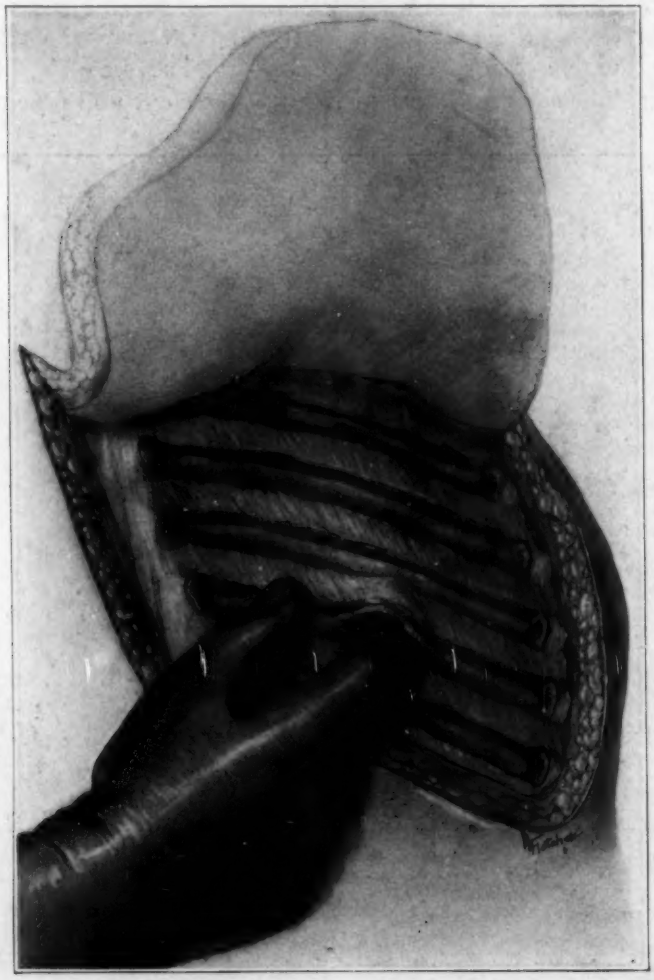

Fig. 3 (stage 1).—Exploration through periosteal sheath to determine presence or absence of adhesions; similar exploration is carried out through each periosteal sheath.

do not exist, and there is risk of pneumothorax, drainage has preferably been omitted.

The choice of the side to serve as the hinge may apparently be left to convenience. Actual experience has shown that the hinge may

be posterior, posterosuperior, superior or anterosuperior without adversely affecting the blood supply. There has been no experience with a flap involving the pectoral muscles or the region of the scapula.

Stage 2.—From three to five days elapse between stages 1 and 2. During this time the lymphatic spaces in the traumatized tissue have

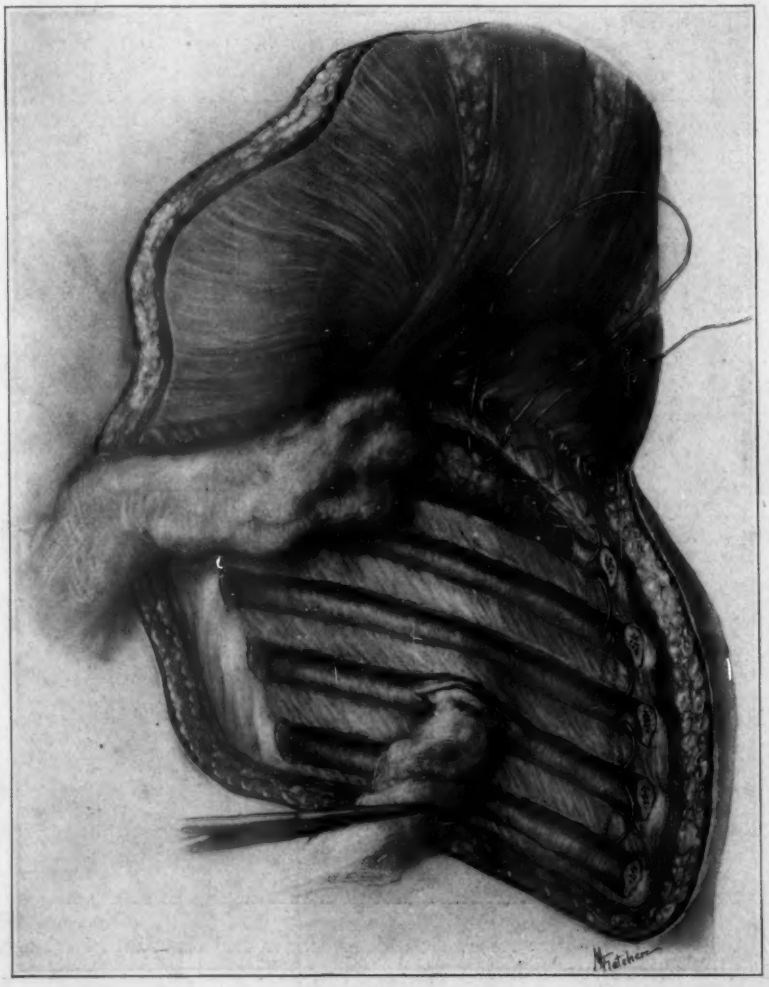

Fig. 4 (stage 1).—In the absence of pleural adhesions it is necessary to suture lung to chest wall, as is here schematically shown. Such suture is impossible if the lung is gangrenous, and in that case a gauze pack is utilized instead. Stage 1 ends at this point and the flap is replaced in its anatomic position.

been sealing off. The second stage is usually accomplished with little distress to the patient. The temporary tacking sutures are removed and the big flap is reopened. The intercostal muscles, periosteal sheaths

and other structures of the chest wall, together with the parietal pleura, are removed en masse, as in the Schede operation. The diseased lung is immediately beneath the eyes and hands of the surgeon. If adhesions are weak, or air is sucking around the edges of the chest wall defect, the flap may again be replaced for a period of one or two days before proceeding. Otherwise, the point of easiest access to the abscess cavity is determined by sight, palpation or needle, now fairly permissible for the first time, and an opening made boldly into the abscess

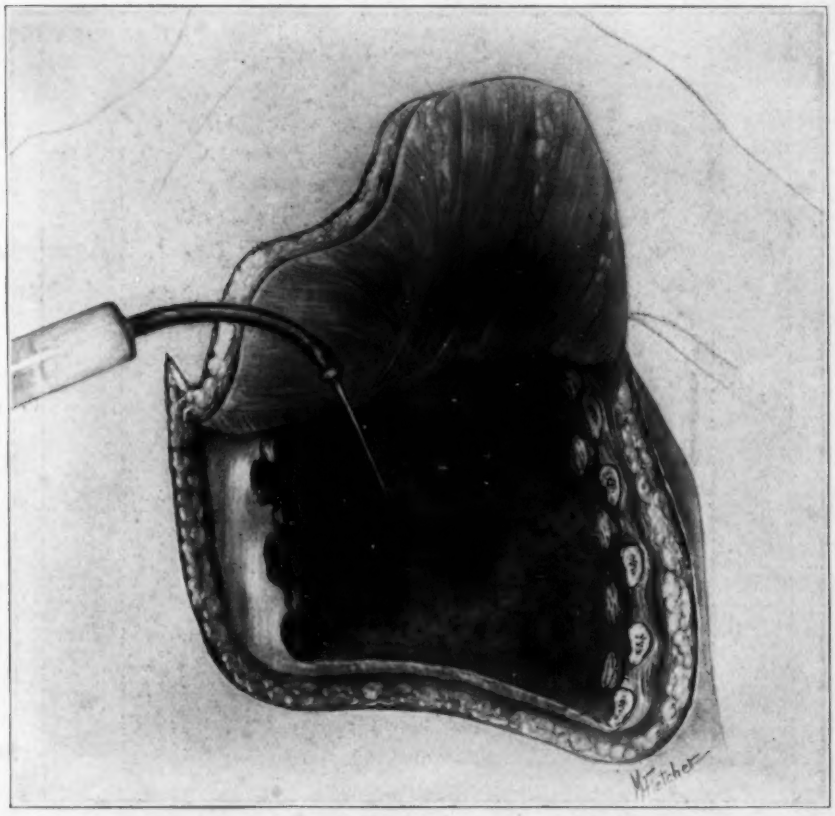

Fig. 5 (stage 2).—Flap reopened; soft structures and chest wall having been excised, the abscess area is located by sight, palpation or exploratory puncture.

cavity by blunt scissors, cautery, knife or trocar cannula. The opening is enlarged to a sufficient degree and packed wide open. The wound edges are protected with strips of petrolatum gauze. The flap is sutured wide open, muscle side exposed, and is so left until the lung tissue is clean enough to permit of secondary closure.

During the period of postoperative care and dressings the flap remains wide open. Constant access to the diseased lung tissue is

assured. The cautery may be employed; any suitable type of dressing may be utilized. Fistulas are under visual control. Accessory pockets can be reached with comparative ease. From time to time a suture holding the flap will pull out; it can be replaced as a minor operative procedure. The majority of patients require one or two elaborate dressings under gas during their period of after-care. It has required from twenty-four to thirty-nine days to prepare the wound for secondary closure. The average time has been thirty-three and one half

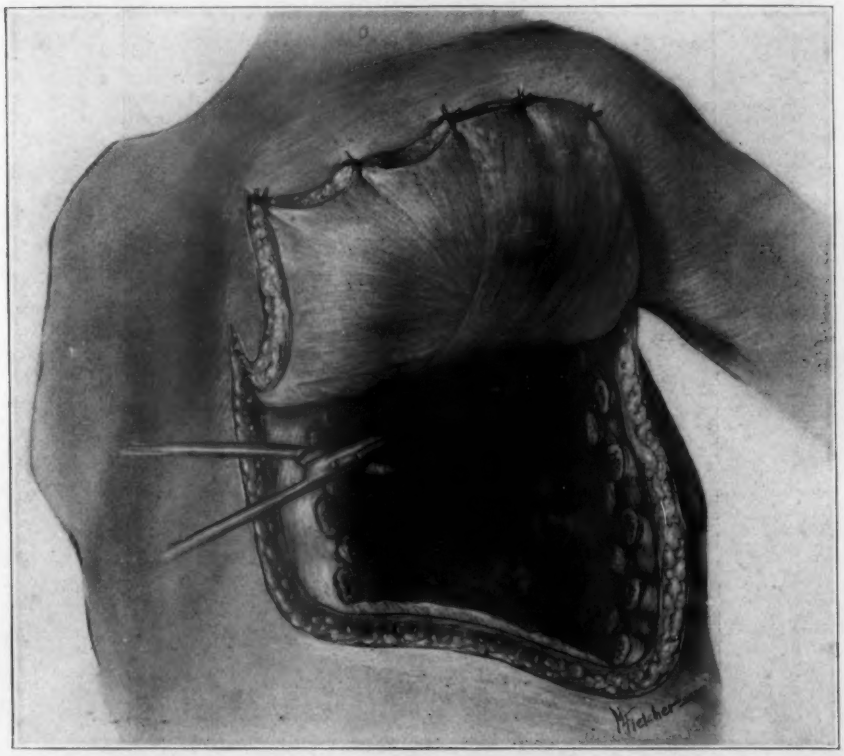

Fig. 6 (stage 2).—Abscess area widely opened by blunt scissors, fingers or cautery; flap is sutured to chest wall, muscle side exposed, and left in this position for from four to six weeks until secondary suture can be safely accomplished.

days. One patient, closed in twenty-four days, had to be reopened and secondarily treated. He then healed permanently.

Stage 3.—This is the simple anatomic replacement of the flap, muscle to muscle, skin edge to skin edge. It is, of course, necessary to freshen the skin edges, to release fibrous bands that tend to wrinkle the flap, and to isolate the edges of the sectioned muscles. A general anesthetic has been preferred for this stage. Safety requires that a

drain leading to the damaged lung tissue be left beneath the replaced flap. Within a relatively short time this may be discarded.

Actual experience with this operation at the Robert Packer Hospital has been limited to six cases. It was first used in January, 1925. The ages of the patients have varied from 2½ years to 57 (2½, 40, 45, 48, 50 and 57). Four cases were diagnosed as abscess of the right lower

Fig. 7 (end-result).—Flap after secondary suture; the flap in this case had been open for thirty-five days.

lobe, and two of these had ruptured into the pleural cavity, giving rise to an empyema as well. One was diagnosed as gangrene of the right lower lobe. One was a subphrenic abscess. Two were postpneumonic. Three, including the subphrenic abscess, followed an

acute intra-abdominal disturbance (ruptured ulcer—ruptured appendix—empyema of the gallbladder). One abscess resulted from a pulmonary infarction seventy-eight hours after a Talma-Morrison operation for hepatic cirrhosis. In every instance, therefore, the thoracic condition was a complication or sequel to a severe illness. There was no mortality in the series.

Fig. 8 (end-result).—Flap after secondary suture; the flap in this case had been open for thirty-eight days; along the upper border of the picture can be seen points to which the flap had been sutured.

Twice stage 1 and stage 2 were combined and carried out as a single primary operation. In the other four instances the two stages were distinct and were separated by from three to five days.

During the after-care cauterization was utilized in two cases. The main reliance was placed, however, on careful dressing attention daily, or more frequently if necessary, and a firm belief that the increased aeration would assure the necessary tissue repair.

In one case the radical operation was done secondarily to a simpler, conservative drainage. The wound had not healed; a fistula had persisted; the patient was at a standstill. After the radical operation cure rapidly followed.

The procedure as described is confessedly radical. It may be criticized on that account; also because it demands a loss of anatomic structures, produces a permanent physiologic impairment, requires three or more operative steps, and presumably subjects the patient to a greater risk. There must be definite advantages to warrant its employment, and the net risk must not be prohibitive. The advantages may be summed up as:

1. Free, complete access to all diseased lung tissue, not only at the time of operation but throughout the entire period of after-care.
2. Free aeration of infected lung tissue.
3. Minimized risk of cellulitis of chest wall.
4. It is well tolerated by the patient and not painful.
5. Ultimate healing is more certain by virtue of the thoracoplasty which is really done at the time of the operation.

Time and further experience alone can determine the advantages and disadvantages of such a procedure and settle its merits. Only the future can evaluate the mortality risk, the subsequent incidence of chronicity, and the prospect of cure or benefit. This is merely a preliminary report. With the accumulation of additional data it is anticipated that a full critical study can soon be presented.

CERVICAL SYMPATHECTOMY

A REVIEW OF THE LITERATURE *

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Surgical intervention with the cervical sympathetic nervous system is a much older procedure than is generally recognized. Prior to 1896 Thomas Jonnesco had performed an operation on the cervical sympathetics in forty-three cases of epilepsy and eight cases of exophthalmic goiter.[1] He gave very incomplete results, but in 1906 he again compiled and published a total of 159 cases in an article read before the German Surgical Congress,[2] many of which had been carefully studied and conscientiously followed. In this paper he reported twelve of 117 cases of idiopathic epilepsy absolutely cured, twenty-five cases of exophthalmic goiter completely recovered and two cases of tic douloureux, one of which was relieved for four years and the other for six months. The report of the two cases of tic was probably stimulated by Jaboulay's suggestion as early as 1899, when he also first suggested the procedure in exophthalmic goiter.

The case reports of epilepsy with recovery of the remarkable number of 10 per cent would seem to be one of the most noteworthy publications of the first part of the century and compares favorably with the 213 cases compiled by Winter [3] a few years previously from several clinics, with 6.6 per cent of cures as compared to 0.79 per cent of cures by conservative treatment in a control series of 1,300 cases. Exception, however, has frequently been taken to the method of judging final results. As early as 1901, after a careful review of the whole matter, Brown [4] declared the operation to be of no value and comparatively lately Bruning [5] has again condemned the procedure.

In theory Jonnesco and Jaboulay agree that interruption of the continuity of the sympathetic system in the cervical region paralyzes vasoconstrictor influences, thus leading to a congestion of the motor cortex of the brain through passive dilatation of the cerebral vessels. This deduction was due, no doubt, to the very evident connection found

* From the Department of Surgery, University of Pennsylvania School of Medicine.

1. Jonnesco, Thomas: Ann. Surg., 1897, p. 513.
2. Jonnesco, Thomas: Tr. German S. Cong., 1906.
3. Winter, G. J.: Arch. f. klin. Chir. **67**:816, 1902.
4. Brown: Arch. f. klin. Chir. **64**:715, 1901.
5. Bruning, F.: Med. Klin. **19**:671 (May 20) 1923.

between the sympathetic ganglions and the internal carotid artery. They seem to disregard, however, that all investigations, anatomic and physiologic, tend to prove that the cerebral vessels, whether the brain is normal or abnormal, are entirely free of vasomotor influences. Their results, therefore, would seem to be unsound in principle, unsubstantiated by experimentation and dubious in actuality. Jonnesco himself appears to have recognized the fallacy of his theory, as he discarded the procedure soon after his report to the German Surgical Congress.

Jonnesco's report of marked improvement in exophthalmic goiter following bilateral cervical sympathectomy cannot be contradicted and has lately been shown to be based on a sound physiologic principle by Reinhard,[6] who showed by photomicrographs that extirpation of the cervical sympathetics of a dog resulted in a reduction of the size of the thyroid on the side operated on, and that chronic irritation of the ganglions induced hypertrophy of the lobe on the side irritated. He therefore concludes that "exophthalmic goiter is entirely due to some abnormality of sympathetic innervation." [6] Following his experimental work Reinhard has tried sympathectomy in eight cases with progressive decline of all symptoms until a complete cure occurred in each case. He excised the superior and middle ganglions with extirpation of the cervical trunk. He observed no ill effects.[6] Deaver in 1902 reported several cases so treated with marked improvement but, following an unexplainable death in two of his series, he abandoned the procedure.

It is interesting to note that at about the time the controversy concerning the efficacy of sympathectomy in thyroid disease was at its height ligation of the arterial supply of the gland was first proposed and later became widely adopted, without, however, any apparent thought that the two procedures may have any connection until Crile only in recent years advocated this theory. It is now, I think, the universal opinion that the improvement from polar ligation is due to interruption of the sympathetic nerve supply and not to any interference with the mechanical distribution of the thyrotoxic products. This certainly appears to be the most logical explanation of the benefits of ligation, as it is inconceivable to suppose that a gland having the rich vascular anastomoses possessed by the thyroid could be materially influenced by merely ligating its large vessels, either in its nutrition, its metabolic activity, or by mechanically hindering the distribution of the comparatively minute amounts of thyroxin secreted daily. Since, then, the only communication between the cervical sympathetics and the thyroid is through the periarterial sympathetics, it would seem to be a much more logical procedure to interrupt this communication by an operation having practically no mortality than to subject the patient to one having an admittedly high

6. Reinhard, W.: Deutsche Ztschr. f. Chir. **180**:170 (June) 1923.

one. However, it still remains for some one actually to prove that the benefits from ligation are due to sympathetic interruption by performing arterial decortication of the thyroid vessels, with careful subsequent observation.

We cannot, of course, disregard the cases of Reinhard, Jaboulay and Jonnesco in which absolute cure was asserted, especially since the most ardent advocate of ligation can claim a cure in only a very small percentage of cases, this operation being used only as a preparation for thyroidectomy. Since, then, a certain percentage of cures can be attained by avulsion of the cervical ganglions the question naturally arises as to whether this operation should supplant thyroidectomy. Klose and Hellwig [7] of Berlin have recently reviewed the whole matter with the careful clinical study of many cases and have come to the conclusion that cervical sympathectomy for exophthalmos may be of some value in severe cases but does not compare with thyroidectomy. This seems to be the general opinion of the great majority of surgeons who are doing "goiter work."

From 1905 to 1915 there was a distinct decline of interest in sypathectomy but in 1916 interest was again revived when Jonnesco first tried the operation as a treatment for angina pectoris. The inspiration cannot be attributed to Jonnesco, however, for as early as 1899 François Franck first suggested severance of the sympathetic nervous supply of the heart as a rational procedure in angina.[8] Neither he nor anyone else, however, attempted the operation until seventeen years later when Jonnesco selected a well marked and typical case and put the thought into execution. This case, with reference to four others, was reported in 1920.[9] His patient was a man of 38, having typical anginal pains at frequent intervals. He was free of a syphilitic history. The operation consisted of ablation of the middle and inferior cervical ganglions and of the first thoracic ganglion, together with avulsion of the cervicothoracic cord between these levels. The operation was confined to the left side. The patient showed no ill effects, convalesced rapidly and was immediately relieved of all symptoms. This relief had been permanent over a four year period when the case was reported. One year later Jonnesco reported the same case at which time he pronounced it as a cure,[10] and a few months subsequent to this he reported in detail progressive improvement, but not absolute cure of his second patient, a man of 54 with typical anginal pains, six months following the same operation.[11]

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7. Klose, H., and Hellwig, A.: Klin. Wchnschr. **2**:627 (April 2) 1923.
8. Franck, François: Bull. Acad. de méd., Paris, May 30, 1899, p. 594.
9. Jonnesco, Thomas: Bull. Acad. de méd., Paris **84**:93 (Oct. 5) 1920.
10. Jonnesco, Thomas: Presse méd. **29**:193 (March 9) 1921.
11. Jonnesco, Thomas: Bull. Acad. de méd., Paris **86**:208 (Oct. 25) 1921.

The immediate results of these articles was to stimulate a renewed interest in the physiology, distribution and pathologic physiology of the cervical sympathetics. These investigations, however, were self-limited; first, because of the impossibility of producing the disease in animals and, second, because of the different anatomic arrangement and distribution of the sympathetics as found in the lower animals. Meltzer in 1920 excised the entire cervical gangliated chain in twenty-eight rabbits and eighty-three cats. Of these, twenty-five rabbits died within ten days and two cats within three days. With the exception of four all of the animals subsequently died, and of the four surviving ones two gave a negative paradoxic eye reflex, showing that the ganglions were not completely removed. Montgomery,[12] on the other hand, at about the same time reported that practically all his animals (cats, rabbits and rats) survived total ablation without any untoward symptoms. He concluded that complete ablation can only be asserted after histologic examination and not by physiologic methods. He also concluded that the sympathetic chain has in itself no endocrine function. Jonnesco, too, refutes Meltzer's analogy by stating that in more than 200 patients operated on between 1896 and 1923 he had never observed such disasters in human beings, either during or after the operation, as were observed in animals.

Following Jonnesco's two cases Tuffier reported a third case following the same technic, with marked improvement.[13] Both these men insisted that only by severance of the cord below the superior ganglion could the impulse be interrupted. Bruning,[14] however, disagreed with with this view and, disregarding the fact that the superior ganglion has apparently no connection with the brain, he advocated its removal. His case, which was the fourth reported, was treated by complete ablation of the three cervical ganglions and the first thoracic. He reported complete relief of symptoms with lowering of the blood pressure.

Following these reports the literature has been abundant with case reports of complete or partial relief by performing Jonnesco's original operation. Borchard [15] reported operation in a man of 54 with complete relief until death three weeks later. In our own country Reid and Friedlander [16] of Cincinnati have carefully observed their first two reported cases with symptomatic relief in both, and Smith and McClure [17]

12. Montgomery, M. L.: Endocrinology **7**:74 (Jan.) 1923.
13. Tuffier, T.: Bull. Acad de méd., Paris **86**:99 (July 26) 1921.
14. Bruning, F.: Klin. Wchnschr. **2**:777 (April 23) 1923.
15. Borchard, A.: Arch. f. klin. Chir. **127**:212, 1923.
16. Reid, M. R., and Friedlander, A.: Sympathectomy for Angina Pectoris, J. A. M. A. **83**:113 (July 12) 1924.
17. Smith, F. J., and McClure, R. D.: Surg. Gynec. Obst. **39**:210 (Aug.) 1924.

have recently reported two cases improved. Diez [18] has reported three patients cured.

Kappis,[19] by the technic of Bruning (total ablation), has operated on a considerable number of patients with good results in all, except one patient in which recurrence of all symptoms occurred four months after operation.

Pleth [20] reported four cases operated on by the Jonnesco method with one death due to postoperative pneumonia. The other three patients are living and have no symptoms.

Hofer and Eppinger,[21] believing that the sensory impulse was carried only by the depressor nerve of the heart, which has its distribution to the suprasigmoid portion of the aorta, early took exception to the Jonnesco operation and advocated section only of this nerve. The depressor nerve was first described as early as 1866 by Ludwig and Cyon in their studies on the rabbit. It arises typically from two heads, one from the superior laryngeal and the other from the vagus, then either reenters the vagus to reach the aorta or courses down along the prevertebral fascia as an independent nerve. Often, however, it is entirely absent, in which case its function is apparently taken up by the vagus.

In their assumption, Hofer and Eppinger have been substantiated by the researches of Tschermak,[22] who found that the depressor nerve is distributed entirely to the proximal aorta, has many connections with the cervical sympathetics, terminates in the jugular ganglion of the vagus and is entirely sensory in function. Tschermak also found that in health stimulation produced a general vasodilatation but when the arch is diseased vasoconstriction results.

Hofer's [23] first patient was operated on in 1922. The patient had typical anginoid pain on both sides of the body. A bilateral operation was performed. The patient recovered and was permanently relieved for two years, when she died of an intercurrent infection. Thus encouraged, Hofer and Eppinger continued their work and in 1923 reported six cases, with four completely recovered, one doubtful and one death from pneumonia.[21] During the current year they again compiled their cases and reported fourteen, in which two of the patients died. In one a bilateral operation was performed in two stages. The depressor on the left was severed. On the right no depressor was

18. Diez, J.: Rev. Asoc. méd. argent. **37**:5 (June) 1924.

19. Kappis: Med. Klin., Nov. 18, 1923.

20. Pleth, V.: Am. J. Surg. **36**:300 (Dec.) 1922.

21. Hofer and Eppinger: In offizielles Protokoll der Gesellschaft der Aerzte in Wien, Wien. klin. Wchnschr. **36**:334, 1923.

22. Tschermak, A.: Wien. med. Wchnschr., 1924.

23. Hofer: Wien. med. Wchnschr., May, 1924.

found, so the vagus was sectioned below the inferior laryngeal. Pain disappeared but the patient died suddenly two weeks later of no obvious cause. The second mortality occurred in a patient in whom no depressor nerve was found, in consequence of which extirpation of the cervical sympathetics was performed. He died five hours later from pulmonary edema.[23]

They report that in all cases in which the depressor nerve was found and cut pain was immediately and permanently relieved and conclude, therefore, that section of this nerve alone will accomplish the same result as ablation of the cervical ganglions, that it is a more logical procedure, is substantiated by experimental findings and offers the least number of technical difficulties. They further suggest that Jonnesco may have sectioned the depressor nerve thinking that it was the superior cardiac nerve in his operation.[21]

The latter statement Jonnesco not only forcibly denies but also asserts that it is utterly impossible completely to interrupt the afferent pathway without ablation below the superior cervical ganglion.[24] He further objects to the procedure, not only because of the difficulty of isolation of the depressor nerve, due to individual variation and inconstancy of origin from the vagus, but also because of the danger of injuring the superior laryngeal nerve, which seems to have occurred in one of Hofer's series, necessitating tracheotomy and ending in death. At any rate it would be just as plausible to assume that Hofer had sectioned the superior cardiac nerve, thinking it was the depressor, as to assume that Jonnesco was in error.

There were now before the profession two different operations, both apparently benefiting the same condition. To these Coffey and Brown[25] in November, 1921, added a marked variation, which later became so modified that it may well be considered as a third form of operation. After selecting a patient with typical angina they decided to do the operation in two stages, the first stage being confined to section of the cord below the superior ganglion and section of the superior cardiac nerve. Following this part of the operation, on the left side only, the patient was completely relieved of pain. They, therefore, decided to do nothing further, and the patient remained entirely free of pain for one year when he was lost track of. They then selected four more cases and performed the same operation on them; that is, section only of the gangliated cord and the superior cardiac nerve close to the ganglion. This made a total of five cases that were reported in 1923,[25] with complete relief in two, partial

24. Jonnesco, Thomas: Presse méd. **32**:138 (Feb. 13) 1924.

25. Coffey, W. B., and Brown, P. K.: Surgical Treatment of Angina Pectoris, Arch. Int. Med. **31**:200 (Feb.) 1923.

(almost complete) relief in two and one death six hours after operation due to "acute vasomotor disturbance with dilatation of the heart."

One of these patients subsequently had a return of most of his symptoms, which would appear to be a fortunate occurrence, as it stimulated in these workers a most happy inspiration. They decided to avulse the superior ganglion.[26] This was done and the patient was completely and permanently relieved of all symptoms.

Following recovery of this patient Coffey and Brown decided to change their operative procedure and to avulse the superior ganglion after sectioning the superior cardiac nerve. This they did in eight cases which were thoroughly studied both before and after operation. Of these eight patients one died as the result of operation, and one two weeks later of myocardial disease. Five were completely relieved and the sixth was relieved of all pain except that referred to the left arm. They concluded that their results were due to severance of the superior cardiac nerve, which they considered as a vasoconstrictor one and not sensory, thus removing spasm of the aortic arch and of the coronary vessels.

There are now, therefore, the following operations before the profession, each with its advocates and each apparently successful in the treatment of the same condition:

1. Jonnesco's original technic: extirpation of the middle and inferior cervical ganglions and the first thoracic ganglion, with or without severance of the superior cardiac nerve.

2. Bruning operation: extirpation of the three cervical and the first thoracic ganglions.

3. Resection of the superior cervical ganglion and severance of the superior cardiac nerve as advocated by Coffey and Brown.

4. Severing the depressor nerve as practiced by Hofer and Eppinger.

In attempting to determine which of these various operations is correct in theory, it becomes necessary to inquire into the pathologic physiology of angina. Of the many theories advanced the following appear to have the most support:

1. That angina is due to myocardial exhaustion.

2. That angina is due either to coronary artery disease or to coronary spasm.

3. That it is due to an arteritis of the first part of the aorta.

The first theory has as its warmest advocate Daniélopolu who contends that angina is due to "cardiac fatigue" caused by intoxication of

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26. Coffey, W. B., and Brown, P. K.: Surgical Treatment of Angina Pectoris, Arch. Int. Med. **34**:417 (Oct.) 1924.

the myocardium by incompletely eliminated fatigue products. In this he was supported by the late Sir James Mackenzie, whose only difference of opinion was an academic one.

The second theory is the oldest and for many years the didactically accepted one until Sir Clifford Allbutt made his extensive studies of angina and concluded that the symptoms are always due to disease of the suprasigmoid region of the aorta. He has "failed to discover an example of unmistakable angina in which, whatever the disease of the coronary arteries, the aorta, on careful examination, was shown histologically to be inwardly and outwardly sound." [27] This opinion has lately also been shared by Vaquez and Wenckebach. Wenckebach admits the presence of coronary disease in many instances but contends that all such cases have associated disease of the proximal aorta and, in addition, that in many cases of true angina only the latter pathologic condition can be demonstrated. He thinks that the cardiac failure is the result and not the cause of angina.[28]

The latter hypothesis being accepted as the correct one, the cause of sudden death during the attack has led to much controversy and difference of opinion. Most of the observers agree that there is a sensory stimulus originating in the suprasigmoid portion of the aorta which is transmitted to the cardio-aortic plexus and carried from there, chiefly by the superior cardiac nerve, but in some instances also by the middle and inferior cardiac nerves to the cervical sympathetic ganglions. The exact course of the impulse from this point is somewhat confused, some physiologists contending that the impulse on reaching the superior cervical ganglion is immediately transmitted to the vagus through the small branches connecting the superior ganglion with the ganglions jugulare and nodosum, while others contend that the impulse first travels down the sympathetic chain to at least the first and probably second and third thoracic ganglions before its transmission to the central nervous system.

Acceptance of the latter as the most probable path is largely due to the work of Mackenzie [29] and Head [30] on the distribution of referred cardiac pain. The studies of these men have clearly shown that the cutaneous areas to which the pain is referred are supplied by the same spinal segments that receive the afferent impulse. Thus, we find that the pain of angina is usually referred to the anterior chest wall and to the inner side of the arm. The chest area is supplied chiefly through

27. Allbutt: Diseases of the Arteries, Including Angina.

28. Wenckebach, K. F.: Paper read before the Royal College of Surgeons, Brit. M. J. **1**:826 (May 10) 1924.

29. Mackenzie, J.: Diseases of the Heart: Symptoms and Their Interpretation, ed. 3, 1918.

30. Head, H.: Brain **16**:2, 1893; ibid. **17**:339, 1894.

the second, third and fourth thoracic nerves. The intercostobrachial nerve, which originates from the second and third thoracic nerves, supplies the skin of the upper and inner side of the axilla and arm. It is through the connection of the intercostobrachial and the greater and lesser internal cutaneous nerves that the pain reflex radiates down the inner side of the arm.

Mackenzie's [29] conception of the production of the reflex is probably the most logical of the various ones advanced. He thinks the afferent impulse after descending the sympathetic chain enters the spinal cord through the white rami of the first, second and third thoracic segments. Normally, this impulse is imperceptible and is constant and uniform. Abnormally, however, the impulse from the diseased arch produces a hyperirritability of these segments and consequently the efferent impulse, which the body has learned to refer only to the somatic distribution of the segments, is also hyperirritable and produces the sensation of pain.

Whether the reflex has its synapse in the cord or in the brain is problematical. That it does reach the brain is generally accepted, largely on account of the observations of Byrne and Einthoven [31] on "action curves" as recorded by the electrosympathicogram; that the impulse ascends through the vagus, however, is questionable, for if this were true the synapse should occur with the nuclei of the glossopharyngeal, the spinal accessory and the trigeminal, and the pain should be distributed in these nerves, which, as is well known, is never the case.

Acceptance of these hypotheses, to which at present there is little dissension, means also acceptance of the theory of retrograde transmission of the impulse through the sympathetic chain, rather than its immediate conveyance from the superior sympathetic ganglion to the vagus.

The immediate cause of death is thought to be vagus inhibition, which occurs with each attack and is supposed to vary in proportion to the intensity of the afferent stimulus.[27]

As regards the depressor nerve there is no doubt of its existence and specificity in cats and rabbits. It is entirely afferent. If the central end of the cut nerve is stimulated, a marked fall of blood pressure with slowing of the heart results.[32] Einthoven has shown by action curves that each heart beat sends an impulse over it.[33] As previously mentioned the anatomy of this nerve was first described by Ludwig and Cyon in 1866, who found that it originates by two heads, one from the vagus and the other from the superior laryngeal, then either courses down along the prevertebral fascia or reenters the vagus. It is dis-

31. Byrne, J., and Einthoven, W.: Am. J. Physiol. **65**:350 (July) 1923.

32. Eyster and Hooker: Am. J. Physiol. **21**:373, 1908.

33. Einthoven: Quart. J. Exper. Physiol. **1**:243, 1908.

tributed to the proximal aorta. In man, however, the nerve is very inconstant in appearance and in many instances is entirely absent, in which case its function is taken up by the vagus. It is this nerve which Hofer and Eppinger have sectioned and concerning which they have had so much controversy with Jonnesco.[34]

The question now arises as to whether the interrupted impulse is afferent or efferent. Pleth has considered it to be the latter and thinks his results are due to abolition of the abnormal vasoconstrictor impulses destined for the root of the aorta, the pain being due to anemia of this region. Coffey and Brown are of the same opinion. Practically all others think it is the sensory pathway that is interrupted, and in this they are supported by physiologic experimentation. In the light of our present knowledge, it would seem that afferent interruption is the most logical theory.

It will now be seen that there are apparently two afferent pathways from the aorta, first, through the superior cardiac nerve to the cervical sympathetics and, second, through the depressor nerve directly to the vagus; furthermore, that interruption of either pathway produces the same results. On closer scrutiny, however, this may not be the case. There seems to be an utter disregard of the fact that there are many communications between the depressor nerve and the cervical sympathetics on one hand [22] and at least two constant connections between the superior cervical ganglion and the vagus. Does it not seem logical to assume that the afferent pathway, regardless of whether it is carried by the superior cardiac nerve or the depressor nerve, must always pass through the cervical sympathetics before its transmission to the central nervous system? This would explain the similar results obtained by Hofer and Jonnesco by what, at first glance, appear to be totally dissimilar procedures. They have interrupted the pathway of sensory impulse regardless of whether that interruption is produced in the sympathetic chain or in the depressor fibers.

The apparent dissimilarities between the various procedures carried out on the cervicothoracic cord are interpreted much more easily. It is merely a question of interrupting the impulse at different levels. The fact that interruption by ablating the cord below the superior ganglion produces the same result as severance of the superior cardiac and ablation only of the superior ganglion lends credence to the theory that all afferent impulses have a retrograde transmission through the cervical chain before reaching the central nervous system. It is entirely probable that all afferent impulses must enter the chain through the superior cardiac nerve, first, because it is this nerve that is distributed to the proximal aorta and, second, because the communication between the

34. Jonnesco (footnotes 21 and 24).

sympathetics and the depressor nerve is through the superior cardiac. This it appears would adequately explain the uniformity of results obtained by Jonnesco, Bruning and Coffey by operating at different levels.

If we admit, then, that these three types of operation are the same in principle, the question naturally arises as to which should be the operation of choice. In deciding this the technical difficulties alone should be the deciding factor. Because of the inconstancy in origin, frequent absence and difficulty of recognition, section of the depressor nerve would appear to offer the greatest technical difficulties and, therefore, should be avoided.

Of the various procedures on the cervical sympathetics themselves the minimum surgical intervention which will produce the maximum result should be selected. In determining the extent of operation one must bear in mind many points. Jonnesco has consistently asserted that avulsion of the middle and inferior ganglion with the first thoracic is not only absolutely necessary to obtain results but also is a safe procedure,[35] while Daniélopolu, on the other hand, is uncompromisingly opposed to removal lower than the middle ganglion, as he believes that three of Jonnesco's patients died from avulsion of the inferior ganglion.[36] Certain it is that avulsion of only the superior ganglion, with severance of the superior cardiac nerve, offers the least technical difficulties and, since the results from this operation compare favorably with the results of more extensive procedures, this would appear to be the operation of choice. The question now arises as to whether a unilateral or bilateral operation should be performed. If the pain is entirely left sided the operation should first be performed on that side with subsequent, but later, operation on the opposite side if symptoms persist or return. In cases of bilateral reference of pain a bilateral operation should be performed, but in stages, the second stage to succeed the first by an interval of not less than from seven to ten days.

The operative technic to those having a thorough knowledge of the surgical anatomy of the neck is simple. It is not, however, a procedure to be recommended to the inexperienced. A longitudinal incision is made along the border of the sternocleidomastoid muscle, exposing it; this muscle is then either retracted backward or split with its fibers through the posterior half. This exposes the sheath containing the vein, artery and vagus nerve. These are retracted toward the midline with two band retractors, sufficiently separated to expose the prevertebral space through a considerable length. The prevertebral fascia is now denuded and shining through it will generally be seen the sympa-

35. Jonnesco, Thomas: Presse méd., May 23, 1923.

36. Daniélopolu, D.: Brit. M. J. **2**:553 (Sept. 27) 1924.

thetic chain. If not, the fascia is carefully incised and stripped back, thus bringing the chain into the field of operation. The nerve is picked up and is then readily followed upward to the superior ganglion where the superior cardiac nerve can be isolated without difficulty and severed. The superior ganglion is then ablated. If further ablation is decided on, the procedure is carried out from above downward, bearing in mind the more common anomalies of the sympathetic chain. The middle ganglion is frequently absent, or the third cervical one may be fused with the first thoracic ganglion. It should also be remembered that exposure of the first thoracic ganglion is rather difficult.

In attempting to estimate the results of sympathectomy for angina there is considerable difficulty. A disease concerning which so little is really known of its pathology and physiologic pathology, whose progress is so variable, whose prognosis is so guarded, whose termination may be sudden death at any stage of an apparently mild case, and in which our present instruments of precision give us so meager knowledge, scarcely lends itself to satisfactory observation after any form of treatment. That sympathectomy does in a great many instances temporarily, and in the majority of cases permanently, relieve the patient of practically all his pain cannot be denied. That it does anything further is only a matter of conjecture. Its most ardent supporters measure success only by relief of pain, and Daniélopolu [36] and Wenchebach [28] have repeatedly emphasized that there is no other benefit. But is this a benefit? Is pain not the distress signal that warns the patient to relax completely and rest until the heart has recovered? Do these patients who are relieved of this "danger signal" exterminate themselves by an unconscious disregard of nature's warning? Who can say? It is true that many of the patients operated on have died suddenly and of no apparent cause, but by what means can we judge that such a catastrophe would not have occurred if the course of their disease were not interfered with? Is not relief of the physical pain and horrible mental anguish sufficient justification for the operation? These are questions just as incapable of solution at the present time as is the nature of the disease itself. We must wait for further knowledge and further observation before attempting to solve them.

EXTRACRANIAL ANEURYSM OF THE INTERNAL CAROTID ARTERY

HISTORY AND ANALYSIS OF THE CASES REGISTERED UP TO AUG. 1, 1925*

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While extracranial aneurysm of the internal carotid artery is not a common condition, it is by no means as infrequent a lesion as hitherto supposed. In a paper in 1921, I was able to compile out of the literature sixty-nine cases, to which I added a personal observation.[1] At that time I thought I had exhausted the field, only to discover later, in a source unavailable then, a number of additional examples of this lesion. By adding these and some cases that have appeared in the more recent literature to my earlier compilation, the recorded instances of extracranial aneurysm of the internal carotid artery show the no insignificant total of 106 cases, divided as follows: spontaneous, forty-two; erosive, eighteen; traumatic, twenty-six; arteriovenous, nineteen, and unclassified, one.[2] But it is not so much the rarity of this lesion, when it does occur, that commands our attention as its propensity to imitate peritonsillar abscess, which habit of mimicry has led on more than one occasion to its lancing, with a mortal hemorrhage. The majority of these patients should recover if the aneurysm is promptly recognized and properly treated, but an overwhelming proportion die under dilatory, blundering or pernicious tactics, as the accompanying tables bear testimony; for this reason I have thought the completion of the history of this lesion of some value to the profession.

Of the 106 patients, forty-nine recovered; two showed improvement; seven were unimproved; the condition of one was not stated and forty-seven died (Table 1). Seventy were operated on, with forty-six cures, two improvements, one recurrence and twenty-one deaths (Table 2). Thirty-five were not operated on, with three cures, six unimproved, one the condition not mentioned and twenty-five deaths (Table 3). One case was found in a dissecting room subject, with no available history,[2] so is valueless for statistical purposes.

Fifty-nine of these patients were operated on since 1880, with forty-one, or 69.49 per cent., cures; two, or 3.39 per cent., improvements;

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1. Winslow, Nathan: Tr. South S. A. **34**:323, 1921; Ann. Surg. **75**:694, 1922.

2. Arnould: Bull. et. mém. Soc. anat. de Paris **89**:168, 1914.

one, or 1.69 per cent., recurrence, and 15, or 25.43 per cent., deaths. Forty-four patients were operated on since 1900, with thirty-one, or 70.45 per cent., recoveries; two, or 4.55 per cent., improvements; one, or 2.27 per cent., recurrence, and ten, or 22.73 per cent., deaths. On the other hand, of the thirty patients not operated on since 1880,

TABLE 1.—*Summary of Cases*

	Cured	Improved	Unimproved	Uncertain	Died	Total Cases
Spontaneous	18, or 42.86%	0	5, or 11.90%	1, or 2.38%	18, or 42.86%	42
Erosive	6, or 33.33%	0	0	0	12, or 66.67%	18
Traumatic	12, or 46.15%	0	1, or 3.85%	0	13, or 50.00%	26
Arteriovenous	13, or 68.42%	2, or 10.53%	1, or 5.26%	0	3, or 15.79%	19
Unclassified	0	0	0	0	1, or 100.00%	1
Total cases	49, or 46.23%	2, or 1.89%	7, or 6.60%	1, or 0.94%	47, or 44.34%	106

TABLE 2.—*Patients Operated On*

	Cured	Improved	Unimproved	Died	Total Cases
Spontaneous	16, or 64.00%	0	0	9, or 36.00%	25
Erosive	5, or 55.56%	0	0	4, or 44.44%	9
Traumatic	12, or 60.00%	0	0	8, or 40.00%	20
Arteriovenous	13, or 81.25%	2, or 12.50%	1, or 6.25%	0	16
Total cases	46, or 65.71%	2, or 2.86%	1, or 1.43%	21, or 30.00%	70

TABLE 3.—*Patients Treated Conservatively*

	Cured	Improved	Unimproved	Uncertain	Died	Total Cases
Spontaneous	2, or 11.77%	0	5, or 29.41%	1, or 5.88%	9, or 52.94%	17
Erosive	1, or 11.11%	0	0	0	8, or 88.89%	9
Traumatic	0	0	1, or 16.67%	0	5, or 83.33%	6
Arteriovenous	0	0	0	0	3, or 100.00%	3
Total cases	3, or 8.57%	0	6, or 17.14%	1, or 2.86%	25, or 71.43%	35

twenty, or 66.67 per cent., died; six, or 20 per cent., were unimproved; in one, or 3.33 per cent., the outcome was not reported, and three, or 10 per cent., recovered. No other argument is needed for recourse to radical arterial surgery than these figures, viz., roughly speaking 70 per cent. recoveries in the operative series against 10 per cent. in the non-operative group, a balance of some 60 per cent. in favor of the former:

or putting it in another way, 25.43 per cent. deaths in the first in comparison with 66.67 per cent. fatalities and 20 per cent. unimprovements in the latter. Until bloodless methods can produce better results, the management of this lesion must remain strictly a surgical problem, and the few cases reported as medical cures should be regarded as a matter of good luck rather than as establishing a sound therapeutic principle for guidance in future emergencies of this character.

Thirty-eight cases were reported as occurring during the last century: spontaneous, twenty-three; erosive, five; traumatic, seven, and arteriovenous, three. Sixty-eight were reported since: spontaneous, fourteen; erosive, thirteen; traumatic, nineteen; arteriovenous, sixteen, and unclassified, one (Table 4).

TABLE 4.—*Cases Occurring Prior to and Since 1900*

	Operated On				Not Operated On				
	Cured	Improved	Unimproved	Died	Cured	Unimproved	Uncertain	Died	Total
Spontaneous.....	10	0	0	7	0	1	0	5	23
Erosive.....	1	0	0	2	1	0	0	1	5
Traumatic.....	3	0	0	2	0	0	0	2	7
Arteriovenous....	1	0	0	0	0	0	0	2	3
Total.....	15	0	0	11	1	1	0	10	38
Since 1900									
Spontaneous.....	6	0	0	2	2	4	1	4	19
Erosive.....	4	0	0	2	0	0	0	7	13
Traumatic.....	9	0	0	6	0	1	0	3	19
Arteriovenous....	12	2	1	0	0	0	0	1	16
Unclassified.....	0	0	0	0	0	0	0	1	1
Total.....	31	2	1	10	2	5	1	16	68
Grand total.....	46	2	1	21	3	6	1	26	106

While conclusions drawn from small series are admittedly often misleading, the difference in the mortality rate of the operative and the nonoperative groups is so peculiarly striking, that one is compelled to attribute the favorable results in the one and the failures in the other to nothing else than the mode of treatment. As approximately three out of four patients coming to operation recover, while four out of five patients treated conservatively die, there should be no hesitancy in the presence of this lesion in recommending an operative attack on the carotid vessels as offering the best, the surest and the quickest prospect of securing permanent relief from the condition.

As a rule the symptoms are frank. On inspection of the throat, there is seen a bulging in the lateral pharyngeal wall. The mass may so encroach on the alimentary tract as to convert the food passageway into a narrow slit. The swelling may be either circumscribed or diffuse. To the touch it is soft and elastic, and pulsates in an expansile manner throughout its entire extent. Externally there may be no evidence of the

disease; or there may be a bogginess; or there may be a distinct lump behind the angle of the jaw. With a stethoscope placed over the swelling a bruit may be heard. Both murmur and pulsation disappear when the common carotid artery is compressed against the vertebral column, to reappear immediately on the reestablishment of the circulation through the affected vessel. With the arrest of the circulation the volume of the mass is greatly diminished. The patient may complain of a roaring in the ear, persistent and severe hemicrania, vertigo and weakness. Swallowing of solids is sometimes impossible and generally accomplished with difficulty. Liquids may be regurgitated through the nose. Dyspnea is a not uncommon complaint. Hoarseness and deviation of the tongue toward the affected side have been observed. Diagnostic puncture has been practiced in obscure cases, but should not be employed unless the patient is so situated that a prompt operation can be done in the event of a rupture through the path of the needle. In an occasional case, the signs of aneurysm are lacking, obscure or atypical. Under such circumstances extraordinary care must be employed to avoid mistakes in diagnosis as an improper interpretation of the condition almost invariably leads to mischievous surgery.

Were this aneurysm more accessible restorative aneurysmorrhaphy would be the ideal treatment. In the arteriovenous type it has been used a few times with entire satisfaction; in the arterial, once by McMullen and Stanton, but the patient died of leakage through the suture line. The operation of choice is ligation of the internal carotid proximal to the aneurysm. If this is impossible, both the common and the external arteries should be ligated and any branches of the latter arising between the site of the ligation and the bifurcation. Before permanently arresting the circulation in the internal carotid artery, the common carotid artery should be temporarily occluded under local anesthesia. Usually a defective cerebral circulation will promptly manifest itself by vertigo or faintness. In the face of these warnings the ligature should be removed without delay.

In this connection I desire to report that the patient operated on by me for an aneurysm of the internal carotid artery in its cervical course still remains completely cured, now more than four years after the operation. In a similar case in which operation was done at the University of Maryland clinic in January, 1915, and which was reported by Shipley and Lynn,[3] the patient is symptomatically well at the time this article is being written, a little over ten years since the operation. These results would seem to indicate that stoppage of the circulation through

3. Shipley, A. M., and Lynn, F. S.: Carotid Tumors, J. A. M. A. **66**:1602 (May 20) 1916.

an internal carotid artery has little if any effect on longevity in those cases in which the patients have weathered successfully the storms incident to such an operation.

SPONTANEOUS TYPE

The cases of spontaneous type number forty-two; twenty-five of the patients were subjected to some form of radical arterial surgery (Table 5), and seventeen were treated conservatively (Table 6). Thirty were women, eleven, men, and in one, the sex was not mentioned. These figures reverse the usual order of events, as aneurysm elsewhere is by far more prevalent in the male than in the female. The ages ranged between 4¾ and 76 years. The right side was affected eighteen times; the left, nineteen; the side was not stated in four. Eighteen patients recovered; eighteen died; five were unimproved, and in one, the condition was not mentioned. Twenty-five were operated on, with nine deaths, or a mortality of 36 per cent., and sixteen, or 64 per cent., cures. The operative fatalities were ascribed to hemorrhage three times; to cerebral complications, once; to hemiplegia, twice; to spontaneous rupture of the sac into the mouth and asphyxia on the operating table, once; to sepsis, once; to no assignable cause, once. Seventeen patients were not operated on, with nine, or 52.94 per cent., deaths; two, or 11.77 per cent., were reported as cured; five, or 29.41 per cent., were unimproved when discharged, and in one, or 5.88 per cent., the condition was not given. The deaths in the unoperated on series were attributed to hemorrhage six times; to coma, once; to cerebral symptoms, once; to undetermined causes, once. The imposition of almost unsurmountable anatomic difficulties to direct attack on the sac renders ligation of the common carotid artery alone or in combination, or of the internal carotid artery alone, as the operations of choice. Once only was aneurysmorrhaphy attempted with death of the patient of secondary hemorrhage from a break in the suture line. Peculiar to relate only in a few of these cases was the aneurysm in this series attributed to syphilis. Castex reports two such cases, in both of which he effected cure by antisyphilitic medication and local measures. No other cases were benefited in the least by antisyphilitic therapeutics. In view of the high mortality rate attached to the conservatively treated series, despite the gratifying results obtained by Castex, some form of radical arterial surgery must remain our sheet anchor in the future as in the past.

The vessels ligated and the results were: common carotid, thirteen times, with eight cures and five deaths; common and external carotids, twice, both patients being cured; common and external carotids and superior thyroid, once, with cure; common carotid, repeated with division five months later for return, once, with cure; common, internal

TABLE 5.—*Spontaneous Aneurysms Operated On*

Case	Author and Reference	Sex*; Age; Side	Duration	Operation Date	Cured	Died; Cause	Remarks
1	Cooper: Lectures, American Ed. 3, 1831, **2**: 62	♂ 50 L	6 months	Ligation common carotid artery, 6/22/1808	Yes	.....	Swelling externally; headache, thumping in the brain; decrease in volume when sac was compressed; regained original size with one contraction of heart; after operation, scarcely an unpleasant symptom; headache relieved; obscure pulsation till September, then felt no more
2	Dupuytren: Leçons orales de clin chir., Ed. 2, 1839, **3**: 56	♀ 76 L	8 years	Ligation common carotid artery, 1/19/1818	....	Yes; 8 days of cerebral complications	Swelling both externally and internally, ovoidal, soft, elastic, expansile throughout, pulsating synchronously with the pulse; beats arrested and lump decreased in size by compressing carotid; overlying skin healthy; dysphagia; mouth opened with difficulty; weakness of left half of tongue; insomnia; after ligation, no return of pulse; necropsy revealed local suppuration, brain negative, calcareous deposits throughout arterial system, aneurysm formed at expense of internal carotid
3	Porter: Dublin Hosp. Rep. **5**: 208, 1830; also Dublin J. M. Sc. **17**: 83, 1840	♀ 40 R	15 years	Ligation common carotid artery, 8/21/1829	Yes	.....	Violently pulsating, tense, globular, cervical swelling, first noticed 15 years before as small pulsating lump which at end of 7 years had only attained the size of a small nut; three weeks before struck her neck, then swelling grew rapidly, became tender and sore on touch; right hemicrania; no pulsation seen in throat; after operation, giddiness, numbness in the right arm, perceptible pulsation in aneurysmal sac; four months postoperative, suppurative sac burst; June, 1830, at her occupation of servant; died, Sept. 7, 1836; necropsy revealed remnant aneurysmal sac internal carotid, with no assignable cause
4	Porter: Dublin J. M. Sc. **17**: 86, 1840	♂ 38 L	5 weeks	Ligation common carotid artery, 9/22/1838	....	Yes; secondary hemorrhage 50th day	Aneurysmal swelling, both internally and externally; intra-oral appearance most alarming, blood column just beneath the mucous membrane, pulsation visible; sac appeared ready to burst. Only 5 weeks had elapsed since the patient had first perceived a freely movable, painless, nonpulsating, small, hard kernel near the angle of the jaw; increased steadily in size and began to pulsate; followed by hoarseness for which he sought relief; operation borne well; no more pulsation or pain; swelling became smaller; October 22, change for worse, headache and stiffness in neck; October 27, fluctuating mass at operative site; cough; dyspnea; dysphagia; incised and much pus admixed with blood recovered; October 30, hemorrhage from wound, repeating itself on numerous occasions till November 12, when patient died; necropsy refused
5	Syme: London & Edinburgh Month. J. M. Sc. **2**: 961, 1842	♀ 60	5 months	Ligation common carotid artery, April, 1842	....	Yes; in 30 hours; no assignable cause	Syme saw patient in consultation; diagnosis was between abscess and aneurysm; Syme leaned to latter; necropsy
6	Duke: Dublin M. Press **19**: 65, 1848	♂ 32 R	1 year	Ligation common carotid artery	....	Yes, in 5 weeks; hemorrhage	Duke was about to puncture a pharyngeal swelling when he introduced a finger and detected pulsation; he changed his diagnosis to aneurysm; a consultant did not consider the condition so serious, and during a visit in the absence of Duke incised the aneurysm; this was followed by such a severe hemorrhage as to necessitate ligation of the carotid; the operation was followed by slight paralysis
7	Chassaignac: Bull. Soc. de chir. de Paris **10**: 83, 1859	♂ 26 L	Short time	Ligation common carotid artery, August, 1859	Yes	.....	Hemorrhage after puncture of a supposed retropharyngeal abscess, calling for ligation of carotid artery; postoperative aphonia; headache for 24 hours; after one year complete recovery

8	Godfray: M. Times & Gaz. **2**: 409, 1882	♂ 28 R	5 months	Ligation common carotid artery, 7/30/1876	Yes	.....	Gradually increasing swelling in the right side of the neck with pulsation and bruit; lump looked as though it would burst at its hind part; dysphagia; syphilitic taint evidenced by nodes in tibia; after operation swelling diminished markedly, to enlarge again; dysphagia returned; August 30, violent hemorrhage; swelling as large as ever, no pulse or bruit; September 3, aspirated some foul smelling blood; Sept. 5, 1876, sac burst into pharynx; September, 1882, patient enjoying good health
9	Dubrueil: Gaz. méd. de Paris **54**: 373; 398, 1883	♀ 28 L	6 months	Ligation common carotid artery and later, in the day, ligated the same common carotid, with external carotid, internal carotid and superior thyroid arteries, 5/29/1883	....	Yes, in 14 days, hemiplegia	Swelling of left soft palate; disturbance of speech and deglutition; lump hard, with no fluctuation or pulsation; diagnosed adenoma or sarcoma; while enucleating, sac torn, free hemorrhage controlled by first operation to recur 1½ hours after patient had been returned to bed; immediately after preliminary operation, aphonia and disturbed respiration; June 10, hemiplegia, same side as operation; died June 12, 1883; necropsy showed extracranial aneurysm internal carotid artery; vagus nerve caught up in primary ligature; hemorrhage at base of brain, right side
10	Wyeth New York M. J. **38**: 428, 1883	♀ 60 L	10 years	Ligation common carotid, external carotid and superior thyroid arteries, 1883	Yes	.....	Unmarried; no children; no evidence of syphilis; for 10 years a thumping in the region occupied by the lump; ringing in the ear for 4 years; hemicrania; increasing swelling; no pain; no apparent cause; after operation, lump decreased in size almost to the vanishing point; headache relieved
11	Creus: El Genio Medico-Quirurgico **30**: 191, 1884	♀ 63 R	2 years	Ligation common carotid artery, 4/13/1884	Yes	.....	Dysphagia; dyspnea; gradually increasing lump in throat, pushing tonsil to midline, beating synchronously with pulse; occupied right side of pharynx; superficial surface smooth, ovoid in shape, expansile in character; pulsation arrested by compressing carotid; bruit present but no thrill; no assignable cause, no evidence of syphilis; after operation, decreased in size, swallowing facilitated; breathing improved, pulsation arrested
12	Agnew: Tr. Am. S. A. **4**: 252, 1886	♀	8 months	Ligation common carotid, superior thyroid and lingual arteries; 2 weeks later, ligation opposite common carotid artery, 1883	....	Yes, in about 3 weeks	Large swelling, both internally and externally, growing slowly; pressure on common carotid caused it to shrink; pulsated throughout; bruit present; no assignable cause; 2 weeks after first operation, pulsation reappeared; after second operation, no sound or motion detectable, mass became quite solid; soon afterward sac ulcerated into mouth; free hemorrhage controlled by packing; patient died of sepsis week after last ligation
13	Hulbert: St. Louis Cour. Med. **16**: 265, 1886	♀ 19 R	.....	Ligation common carotid artery	....	Yes, on table, of asphyxia from rupture of sac into mouth	At first diagnosed as abscess, but diagnosis changed to aneurysm on aspiration of pure blood; pulsation present, but no bruit or thrill; during process of isolating internal carotid, sac burst into mouth; temporary ligature which had been placed around common carotid for emergency purposes was tightened; although this controlled the further escape of blood, patient died on table of asphyxia from blood aspirated into bronchi, notwithstanding a prompt tracheotomy; diagnosis confirmed by necropsy

TABLE 5.—*Spontaneous Aneurysms Operated On—(Continued)*

Case	Author and Reference	Sex*; Age; Side	Duration	Operation Date	Cured	Died; Cause	Remarks
14	Clementi: Riforma med. 6 : 478 (Part 1) 1890	♀ 24 L	1 year	Ligation common carotid artery, 8/3/1889	Yes	.....	Ovoid, increasing, pulsating swelling in front of left ear; no cause; internally a bulging pulsating mass, pushing the tonsil toward the right; bruit; compression practiced for 26 days without benefit; after 4 months, complete cure; mass much smaller, nonpulsating and left tonsil symmetrical with right
15	Polak: Weekblad. Nederl. Tijdschr. 36 : 1213 (Part 1) 1900	♀ 65 L	.....	Ligation common carotid artery, 9/27/1894; ligation common carotid artery, 4/24/1895	Yes	.....	Growing potato sized tumor in left side of neck; buzzing in ear; dizziness; pulsation evident to sight and touch; compression of common carotid caused partial diminution in volume of mass; on right side of neck in course of external carotid a pulsating tumor the size of a hazelnut; diagnosis, bilateral carotid aneurysm, without assignable cause; some weeks later aneurysm of right external carotid artery had about disappeared from self applied compression; 5 months later symptoms had returned in left side of neck; at second operation aneurysm was seen to be arising from internal carotid; some weeks later slight pulsation observed in small, hard mass; 5 years later patient again visited Polak for sleeplessness; annoying thumping in right side of neck; dizziness, ascribed to aneurysm of right external carotid that had gradually attained the size of a hen's egg; March 22, 1900, right common carotid artery ligated; patient, now aged 71, left hospital 10 days later, completely cured
16	Mayo, C. H.: St. Paul M. J. 1 : 751, 1899	♀ 29 R	6 years	Ligation common carotid artery, 8/2/1899	Yes	.....	Internally, mass extending to midline; externally, mass behind right jaw; pressure caused it nearly to disappear; pulsation; bruit; right half of tongue atrophied
17	Helferich, in Werner: Ztschr. f. Chir. 67 : 592, 1903	♀ 58 R	8 months	Ligation common and internal carotid arteries, 5/3/1902	Yes	.....	Hard, superficially smooth, nonpulsating, nonfluctuating pharyngeal lump; exploratory puncture, no liquid withdrawn; diagnosis, lymphosarcoma; during attempted buccal extirpation, ruptured sac, profuse hemorrhage, oral tamponading, low tracheotomy; postoperative paralysis of hypoglossal nerve and some disturbance to deglutition
18	Narath: Nederl. Tijdschr. v. Geneesk. 39 : 1174, 1903	♂ 28 R	4 weeks	Ligation common, external and internal carotid arteries, 2/1/1897	Yes	.....	Lump right side of neck of 4 years' duration, attributed to lifting of heavy burden; had taken on increasing activity, causing dysphagia and right hemicrania; single, had never had syphilis; no syphilitic stigmas; patient living and well 5 years after operation
19	Van Campen: Nederl. Tijdschr. v. Geneesk. 39 : 1172, 1903	♀ 58 R	.....	Ligation common carotid artery	Yes	.....	Swelling, both internally and externally; abscess was considered, but pulsation made this supposition untenable; dysphagia; strange feeling in throat; change in voice; after operation, lump disappeared, pulsation arrested, swallowing regained
20	Jianu: Rev. de chir., Bucuresti, 13 : 596, 1909	♀ 23 R	8 years	Ligation common carotid artery	Yes	.....	Also an intracranial aneurysm of internal carotid, the sac of which projected into orbit; symptoms, right hemicrania; noises in head; insomnia; exophthalmos; epistaxis; orbital sac pulsated and had a systolic blow; volume lessened when compressed; fusiform, expansile swelling in neck with systolic blow; volume much diminished on compression of common carotid; on attempt to enucleate the cephalic aneurysm, its sac ruptured; controlled by inserting finger into rent until common carotid could be ligated; bleeding recurred when finger was withdrawn but in considerably less amount and was entirely checked by invaginating sac with a sterile cork stopper placed in hole and held in position by suturing overlying skin; at time of report the buried cork had been borne well; although no history of syphilis could be obtained, patient was given antisyphilitic medication

21	McMullen and Stanton: Ann. Surg. 51 : 76, 1910	♀ 60 R	1 year	Endo-aneurysmorrhaphy, 12/29/1908	....	Yes, in 20 days; secondary hemorrhage	Painless, pulsating, steadily developing mass in right side of neck; no cerebral symptoms; no specific history; swelling in throat; 15 days after operation, patient discharged as cured, to return 3 days later with hematoma under scar; this was opened on the twentieth postoperative day, followed by a copious hemorrhage, arrest of which was obtained by packing the sac; patient went into collapse and died in a few hours
22	Perthes, in Keppler: Inaugural Dissertation, University of Leipzig, 1910	♀ 44 L	3 months	Ligation common, external and internal carotid arteries; extirpation of sac, 7/19/1909	....	Yes, July 26, 1909; hemiplegia	Widow; 2 children; no miscarriages; fulness in neck for 3 months; sticky sensation in throat; dyspnea, for which she consulted Lohse, who detected a firm, elastic mass in left side of pharynx and wavered in diagnosis between aneurysm and abscess; no discernible sclerosis of palpable arteries; pharyngeal mass was covered with a normal mucous membrane, was firm and elastic in consistency, and pulsated; exploratory puncture made and pure blood aspirated; behind left jaw a bruit and pulsation; with ligation, the pulse disappeared; 9 hours after operation, aphasia; paralysis of right arm and right half of face; fully conscious; no pain in head; spasms of right extremities; no improvement; necropsy; thrombosis left anterior cerebral artery and its branches; softening of anterior two thirds of left cerebrum; walls of aneurysm showed no calcareous deposits
23	Moser: Inaugural Dissertation, Kaiser Wilhelm's University, Strasburg, 1911, p. 7	♀ 60 R	6 days	Ligation common and internal carotid arteries; extirpation of sac, 7/7/1910	Yes	.....	Patient had 2 pregnancies; had lifted a bundle of wet grass to her head, next day roaring in right ear and succeeding day lump in right side of neck; no pain; buzzing worse; cephalgia; lump was firm, elastic, oval, pulsated synchronously with the radial pulse, size of hen's egg; thrill; bruit; disappeared on compressing primitive carotid; emptied when compressed, to refill as soon as compression was removed; nothing abnormal in mouth; after operation, severe pain right side of head, impediment to speech, paralysis right arm and leg and lower left side of face; dysphagia, no sensory disturbances; no evidence of arteriosclerosis in sac; discharged in good condition
24	Shipley and Lynn: J. A. M. A. 66 : 1602, 1916	♀ 41 L	2 years	Ligation common and external carotid arteries, 1/31/1915	Yes	.....	White, woman, with bulging in left side of throat; increasing dyspnea; dysphagia, and with slight external evidence; its inner surface was smooth, elastic to touch and pulsated throughout; bruit heard; some months after operation, pulsation had returned but in weaker form; no cerebral symptoms during or after operation; 10 years after operation patient entirely free of any disagreeable symptoms; no history of syphilis; Wassermann test negative
25	Winslow: Ann. Surg. 75 : 694, 1922	♀ 48 R	9 months	Ligation common and external carotid arteries, 2/1/1921	Yes	.....	Swelling in region of right tonsil lanced by local physician for abscess, blood alone escaping; lump gradually grew larger, causing dysphagia and dyspnea, pulsated, and had a systolic blow; externally, puffiness behind angle of jaw; all motion in sac ceased with tying of ligature; after operation patient complained of slight headache for a few days; July 31, 1925, she was entirely well, could swallow beverages and solids with perfect satisfaction; roaring in right ear had ceased and thumping in head had disappeared; said she did not have syphilis; Wassermann test negative; roentgen-ray examination of cervical vertebrae negative

* In this and the following tables, ♂ indictes male; ♀, female.

TABLE 6.—*Spontaneous Aneurysms Not Operated On*

Case	Author and Reference	Sex; Age; Side	Duration	Cured	Died; Cause	Remarks
26	Perier: Rec. de mém. de méd. et de chir. et de phar. militaires **14**: 311, 1854	♂ 19 L	14 days	....	Yes, soon; hemorrhage	Dec. 4, 1843, complained of pain in left temporomaxillary joint, but no swelling or change in color of skin; however, movements of the articulation were embarrassed and limited; pain and rumbling in left ear; at this time nothing abnormal in mouth; December 7, bogginess behind angle of jaw, which could scarcely be opened sufficiently to permit introduction of little finger; velum of palate was pushed by a swelling far toward right; dysphagia; external tumefaction, deep seated, nonpainful on pressure and obscurely pulsating; December 9, hemorrhage from the mouth and nose, repeated frequently; though symptoms were obscure aneurysm of internal carotid was diagnosed; December 16, while Recamier was introducing a finger into mouth, sac ruptured and patient soon died; necropsy confirmed diagnosis
27	Pircher: Wien. med. Wchnschr. **12**: 553, 596, 1862	♀ 5 L	1 month	....	Yes, in one month; hemorrhage	Condition diagnosed as abscess; external swelling; could not open mouth; made an incision, but did not reach abscess; consultants were of opinion that lesion was inflammatory; on their advice inserted a trocar again, without result; child died Feb. 7, 1862, of hemorrhage into mouth; necropsy revealed aneurysm of internal carotid artery
28	Coomes: M. Herald **7**: 503, 1885	♀ Woman L	10 days	....	Yes, in 10 days; hemorrhage	White courtesan, first seen Dec. 14, 1885, for hemorrhage from mouth and nose; said she had never had syphilis, no stigmas of syphilis present; pain in left ear; some puffiness of neck and a protrusion into pharynx which had appearance of an abscess; Coomes had proposed putting a knife into it, but sticking a finger into the mouth, he felt its surface hard and unyielding; the cutting was therefore abandoned; externally no pulsation felt; only after several days' observation was pulsation detected, both internally and externally; also a lump both on inside and outside of mouth; bleeding recurred at intervals until December 23, when patient died; necropsy revealed aneurysm of internal carotid
29	Vander Veer: Tr. Am. S. A. **4**: 253, 1886	♂ 40 L	2 months	....	Yes, in about 3 months; suddenly	Swelling in left side of pharynx and extending to median line; pulsation; bruit; compression of common carotid lessened its volume; treated on two separate occasions by digital compression to common carotid; after apparently having been cured, he experienced severe pain in head and toppled over dead; necropsy could determine no definite cause for death
30	Richardson: J. A. M. A. **15**: 180, 1890	♀ 35 R	Short time	Unimproved	.....	Bulging, pulsating mass in righ lateral pharyngeal wall; bruit; reached to midline; compression of common carotid caused decrease in its volume and arrested pulsation; patient was annoyed by thumping; blood seemed to be just beneath mucous membrane and it appeared with each pulsation that the swelling must rupture; patient drifted out of sight without having received any treatment
31	Edmunds: Tr. Path. Soc. London **43**: 42, 1891	♂ 36 R	1 month	....	Yes, in 12 days; coma	Pulsating tumor in right side of neck, rapidly increasing in size; no pain or discomfort; giddiness; syphilis 12 years before; examination caused attacks of giddiness and fainting, so operation was rejected; necropsy: aneurysm of internal carotid close to its origin
32	Minich: Pest. med.-chir. Presse **38**: 765, 1901	♀ 30	3 weeks	....	Yes, in 3 days; hemorrhage	Intrabuccal swelling; dyspnea; mistaking swelling for an abscess, her physician made an incision into it, obtaining pure blood; hemorrhage arrested with difficulty; followed two days later by a mortal hemorrhage; neither pulsation nor fluctuation; necropsy: aneurysm of internal carotid, projecting into pharynx; in discussion Ihrig cites a similar case observed in 1894 which ruptured spontaneously, but supplies no data
33	Texier: Bull méd. Paris **21**: 593, 1907	♀ 74 L	1 year	....	Yes, in 7 days, cerebral symptoms	Swelling occupying entire left half of pharynx and pushing tonsil and uvula to right; externally no suggestion of swelling; mass in mouth did not pulsate and as its upper part was soft it was thought to be an abscess; trocar stuck into it for diagnostic purposes obtained pure blood; diagnosis: aneurysm of internal carotid or a vascular tumor; necropsy: aneurysm of internal carotid artery, without assignable cause; coma attributed to cerebral edema
34	Texier: Bull. méd. Paris **21**: 593, 1907	♀ 47 L	Short time	Unimproved	.....	Swelling in throat; occasional sensation of an obstacle in throat; dyspnea at night; no noises in ear; surface of mass smooth; pulsated at its lower end only; soft bruit, both internally and externally; iodid of potassium was advised and patient requested to return later, reserving till then advisability of ligating carotid artery
35	Texier and Levesque: Gaz. méd. de Nantes **28**: 466, 1910	♀ 42 L	.....	Unimproved	.....	Swelling in left wall of pharynx; patient felt pulsation corresponding to beats of pulse in the half of head and neck of diseased side; externally no appreciable fulness; not tender to touch; not expansile; not pulsatile; no fluctuation; no operation; antisyphilitic treatment

36	Wagner, in Keppler: Inaugural Dissertation, University of Leipzig, 1910, p. 14	Child	.....	....	Yes; hemorrhage, spontaneous rupture of sac	Physician called to open tonsillar abscess, but forgot to take his pocket case along; the next morning he learned child had died during night
37	Liébault and Daudin-Clavaud: Arch. gén. de chir. de Paris 8 : 1436, 1912	♀ 75 R	18 months	Unimproved	.....	Pharyngeal swelling; dysphagia; impairment in speech; no pain; said she had never had syphilis; mass almost completely blocked oropharynx, was smooth, regular, tense, covered with healthy mucous membrane; pulsated synchronously with radial artery; was expansile; nothing abnormal externally; pressure on common carotid arrested pulsation; no souffle heard; patient refused operation
38	Velebil: Casop. lék. Cesk. Prague 52 : 975, 1913	♂ 4¾ R	3 weeks	....	Yes, Jan. 4, 1913; hemorrhage from mouth	Admitted Dec. 26, 1912, for pain in neck, fever, bulging mass in right pharyngeal wall; it was red, soft, nonpulsating; externally a soft and weakly pulsating mass; pulsation stopped by pressure on common carotid, to begin as soon as compression was discontinued; retropharyngeal abscess suspected, but incision withheld on account of pulsation in unison with that of large cervical vessels; Jan. 4, 1913, Kafkovi made without anesthesia an incision over external swelling; during procedure child coughed and spat up quantity of blood; compression made on common carotid without avail and bleeding was only brought under control by tamponading pharynx, but child died; necropsy: aneurysm internal carotid, no assignable cause
39	Cannuyt: Arch. Franco-Belges de Chir. 25 : 404, 1921-1922	♀ 58 L	.....	Unimproved	.....	Had had two miscarriages; on deep palpation, small, doughy mass behind angle of left mandible; springing from left pharyngeal wall was lump that was soft and pulsated throughout; digital compression of common carotid arrested pulsation in and caused a shrinkage in, volume of mass, which regained its original volume and pulsated as vigorously as ever immediately compression was removed; exploratory aspiration yielded pure blood; structures supplied by ninth, tenth, eleventh and twelfth cranial nerves paralyzed, i. e., left side of soft palate, tongue, vocal cord, sternomastoid and trapezius muscles; gustatory sensations diminished on left side; hoarseness; skiagraph of cervical vertebrae nothing abnormal; Wassermann reaction negative; although there was nothing in history suggestive of syphilitic origin, except two miscarriages, a course of mercury was instituted, supplemented by prolonged compression after which author intended to ligate common carotid artery; he considered aneurysm of spontaneous origin
40	Portmann and Dupouy: Arch. méd. belges 76 : 97, 1923	♂ 68 L	Uncertain	....	.....	First seen, Oct. 24, 1922, for expansile swelling in left pharyngeal region of uncertain duration; buccal surface smooth and covered by healthy mucous membrane; activated by beats synchronous with pulse; elastic to touch, but not tender; no pain; no dysphagia; no interference with speech; superficial temporal pulses beating in unison; eyegrounds not diseased; Wassermann reaction negative
41	Castex: Ann. de méd. 16 : 138, 1924	♀ 46 L	.....	Yes	.....	Widow, decipara, of which three were abortions, first seen in October, 1920, for swelling in left parotid region, accompanied by a systolic bruit and a pharyngeal tumor which pushed left tonsil to median line; spherical in outline, pulsating, soft, elastic, expansile; behind angle of jaw also a mass animated by beats and expansion and the seat of a souffle; with compression of common carotid mass materially diminished in size; bruit and expansion disappeared, to return immediately when compression was released; roentgen-ray examination negative; in 1917, had been treated by Lanari for syphilitic aortitis; diagnosed condition extracranial aneurysm of internal carotid and advised antisyphilitic treatment, rest in bed, ice locally, light compression and injections of gelatin; in November, 1923, aneurysm was half its original size, and scarcely perceptible both internally and externally; in neck was hard resistance without beats or expansion which furnished a double murmur on auscultation
42	Castex: Ann. de méd. 16 : 138, 1924	♀ 45 R	About 6 years	Yes	.....	Single, nurse, English, first seen July 29, 1921, for a swelling in right parotid region, growing, pulsating; dysphagia; noise in right ear; had syphilitic stigmas, such as aortitis; intraoral and extra-oral lump, pulsation, firm; systolic thrill; bruit; temporal pulse normal; tonsil displaced to left; murmur, pulsation, expansion, volume considerably abated by compressing common carotid, to quickly return when compression was discontinued; roentgen-ray examination negative; no nerve disturbances; diagnosd aneurysm internal carotid of syphilitic origin; under rest, ice locally, injections of gelatin and mercury for 3 months; much improvement in subjective and objective symptoms, and by intermittent use of this treatment to November, 1923, practically cured, aneurysm half its original size, weakly pulsatile, feebly expansile, increased consistency

and external carotids, once, with cure; common and internal carotids, once, with cure; common, external and internal carotids with extirpation of sac, once, with death; common and internal carotids, above and below sac and extirpation of sac, once, with cure; common carotid, superior thyroid, lingual and opposite common carotid, once, with death; common carotid, repeated later the same day and in addition the external and internal carotids and superior thyroid, once, with death; common carotid and plugging of hole in an orbital sac with a piece of cork, opened accidentally on account of two aneurysms, one in the neck, and one partly within the cranium and partly orbital, once, with cure.

Chassaignac lanced a retropharyngeal swelling for abscess, but fortunately cured the patient by ligation of the common carotid artery. Dubrueil mistook a pharyngeal swelling for sarcoma and during an attempt at enucleation tore the sac wall. The escaping blood was arrested by a ligation of the common, internal and external carotid and the superior thyroid arteries, but the patient died fourteen days later of hemiplegia. Helferich had the same accident befall him, but fortunately saved his patient by a ligation of the common and internal carotid arteries. Hulbert was saved a similar fate when he inserted a needle into the sac and withdrew pure blood. Though Agnew ligated both common carotid arteries and the superior thyroid and lingual arteries on the side of the lesion, the current was reestablished in the internal carotid, with rupture of the sac and death from sepsis. The case of Jianu is extraordinary. There were two aneurysms in the course of the internal carotid, one cervical and the second projecting from within the cranium into the orbit and presenting at the naso-orbital junction. While attempting to enucleate the latter, Jianu tore the sac wall. To control the escaping blood he inserted a finger into the hole and then proceeded to ligate the common carotid. As there was still some oozing from the rent when this was accomplished, Jianu invaginated the sac wall with a piece of cork and sutured the skin over it to keep it in place. Happily the patient recovered.

Radical artery surgery needs no further brief than 64 per cent. cures against 11.77 per cent. when other tactics are employed. Another and important lesson taught by these studies is that in the presence of a unilateral pharyngeal swelling before puncture one should listen, feel and touch. Among others Minich reported a case in which an attending physician had lanced for abscess. With difficulty the hemorrhage was checked but two days later the bleeding recurred and could not be arrested. In this case neither pulsation nor fluctuation was felt. Wagner was spared a like experience by forgetting to take along his instruments. When he returned the next morning he was told that the patient had died during the night of hemorrhage from the mouth.

Vander Veer believed he had effected a cure by digital compression of the common carotid artery, but three months after the initiation of the treatment the man fell dead. Edmunds refrained from operation because examination caused giddy spells and faintness. The cases of Perier, Pircher, Coomes and Wagner are a grim reminder that death ever threatens from spontaneous rupture into the mouth when the proper surgical measures are withheld.

Though not eligible for tabulation, the following cases merit notice here. Walsham [4] reports a case of aneurysm involving all three carotids. The patient was a man, aged 49, with a nonpulsatile swelling in the right side of the neck of six years' duration. The growth was the size of a cricket ball, globular, hard, and extended from the jaw almost to the clavicle. Until operation, it was thought to be a malignant tumor. A dry tap was made. There was no bulging in the throat, no dyspnea, and no dysphagia. The operation performed, Dec. 5, 1895, consisted of ligation of the common, external and internal carotids with enucleation of the sac. The patient was cured. Deaver [5] cites a similar experience. The patient, a man, aged 46, had had a swelling in the right side of the neck for twenty years. All three carotids were involved in the dilatation. The common carotid artery was tied successfully, Sept. 25, 1888. Prosser [6] and Langenbuch [7] report cases that have been cited as aneurysm of the internal carotid artery, but owing to insufficient evidence these have had to be omitted from my series. Prosser's patient, a woman, aged 70, had had a pulsating tumor in front of the right ear for a number of years. Pulsation disappeared after ligation of the common carotid artery and the swelling diminished, but before very long reappeared. Langenbuch's patient was a woman, aged 66, with a pulsating mass in the left lateral portion of the neck, with an audible souffle. Ligation was not practiced because of the age of the patient. An attempt was made merely to narrow the lumen of the vessel by means of a silk ligature so as to lessen but not interrupt the current of blood. Following this procedure the pain and pulsation were less intense.

Ott [8] cites the case of a woman, aged 26, who went to the Mayo Clinic for consultation, Feb. 14, 1913. Six years before she had had bleeding from the right ear. One year afterward she was seized with severe throbbing, pain in the head, dizziness and bleeding from the ear

4. Walsham: Proc. Roy. M. & S. Soc. **12**:71, 1899; also Tr. M. & S. Soc., London **82**:223, 1899.

5. Deaver: Univ. M. Mag. **1**:340, 1889.

6. Prosser: Brit. M. J. **1**:530, 1897.

7. Langenbuch: Mercredi méd. **3**:21, 1892.

8. Ott, W. O.: Results of Twenty-One Cases of Surgical Treatment of Aneurysm, Ann. Surg. **74**:517-522, 1921.

of more or less intensity. Examination revealed a pulsating tumor in front of the right ear and another in the left submaxillary space. The patient could scarcely open her mouth. A diagnosis was made of aneurysm of the right external carotid artery for the one lump and of aneurysm of the internal carotid artery for the mass on the opposite side. The right external carotid artery and internal jugular vein were ligated, Feb. 20, 1919. Six days later the left common carotid artery was tied just below its bifurcation for an aneurysm which apparently involved both the internal and the external carotids. The patient reported two years later that the aneurysm had shown no signs of recurrence.

Meyer [9] reports what he believes eight examples of aneurysm of the extracranial portion of the internal carotid artery. All the observations were made at necropsy on mentally deranged patients. From the solitary illustration featuring the article and the subject matter of the text, the condition appears rather to have been a slight thickening of the arterial wall at its point of origin. Shaefer,[10] following the lead of Meyer, describes the same condition as aneurysm of the internal carotid artery. Macfarlan [11] does not offer sufficient evidence to justify the acceptance of his cases as aneurysms of the cervical portion of the internal carotid artery. The first observation concerned a woman, aged 58, who sought relief for a whistling noise in the right ear of two years' duration, which kept her awake at night. Listening in the region of the right ear Macfarlan heard a slight systolic murmur, synchronous with the pulse. The author thought the condition due to an extracranial aneurysm of the internal carotid located near the base of the skull. The second patient, a woman, aged 62, complained of ear noises. These became gradually worse and prevented sleep. May 8, 1920, a slight pulsation was seen in the upper part of the neck in front of the left sternocleidomastoid muscle. When one listened over this area with a stethoscope a faint bruit was heard. It was blowing and in unison with the pulse. The disability was attributed to an aneurysm in the upper portion of the common carotid artery or at the beginning of the internal carotid. Though wanting in data, the case of Hodgson, related by Partridge [12] in the discussion on Liston's paper, has every appearance of being a genuine aneurysm of the internal carotid. The patient was a child, aged 9 years, with involvement of all three coats of the artery.

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9. Meyer, Ludwig: Ueber aneurysmatische Veraenderungen der Carotis interna Geisterkranker, Arch. f. Psychiat. **6**:84, 1875.

10. Shaefer: Allg. Ztschr. f. Psychiat. **34**:483, 1887.

11. Macfarlan: J. Ophth., Otol. & Laryngol. **24**:390, 1920.

12. Partridge: Lancet **1**:866, 1842.

The cases of Hunter and Marchal, cited by Wyeth,[13] though very suggestive, could not be confirmed. Hunter's patient was a woman, aged 60, with an aneurysm in the mouth, for which ligation of the common carotid was practiced, followed four days later by death. Marchal opened an aneurysm for an abscess. To arrest the bleeding he ligated first the external carotid artery but did not bring the hemorrhage under control until the common carotid artery also was tied; the patient died, however, six days afterward of cerebral complications. The patient was a man, aged 25, with a swelling in the left side of the throat of two months' duration.[14]

EROSIVE TYPE

Altogether I could discover the case reports of only eighteen examples of this aneurysm published in the domestic and foreign literatures. The smallness of the number is undoubtedly due to the hesitancy of physicians to report their failures, notwithstanding that equally as important lessons are to be learned from mistakes as from successes. Of all the varieties of carotid aneurysm, this is by far the most weird, the most confusing, the most treacherous. The series, as a whole, is a pathetic exhibition of colossal blunders in diagnosis and in treatment.

Of the eighteen patients, twelve died and six recovered. Twelve were males; five females, and the sex of one was not mentioned. Eleven were twenty or under, five over twenty. The ages varied between 11 months and 60 years. In one instance the age was not recorded. The left side was affected twelve times; the right, six. Radical operation was done nine times (Table 7). Of these patients, five, or 55.5 per cent., recovered, and four, or 44.5 per cent., died. The deaths were attributed to hemorrhage twice; to sepsis, exhaustion and hemorrhage, once, and to pneumonia, once. Of the nine cases not subjected to arterial surgery, one, or 11.2 per cent., recovered and eight, or 88.8 per cent., died (Table 8). The causes of death in the unoperative series were spontaneous hemorrhage, four times; anesthesia, once, and hemorrhage from puncture of the sac, three times. Though operative relief holds out the prospect of only 55.5 per cent. cures, this percentage contrasts more than favorably with 11.2 per cent. cures when a watchful policy is adopted. The vessels ligated were: common carotid, five times, with two cures and three deaths; common carotid and splitting of sac, once, with cure; common carotid and internal jugular vein, once, with death; common carotid and division, later internal and external carotids and extirpation of sac, once, with cure, and internal carotid, once, with cure.

A spontaneous cure was reported by Lyot and Petit. The patient had had scarlet fever, followed by a severe inflammation of the throat,

13. Wyeth: Tr. A. M. A. **29**:56-58 (Appendix), 1878.
14. Norris: Am. J. M. Sc. **14**:14, 1847.

TABLE 7.—*Erosive Aneurysms Operated On*

Case	Author and Reference	Sex; Age; Side	Duration	Operation Date	Cured	Died; Cause	Remarks
1	Liston: Lancet 1: 864, 1842	♂ 9 R	2 months	Ligation common carotid artery, 1841	....	Yes, in 15 days; hemorrhage	Six years before had scarlet fever; two months before, cough, fever and small swelling beneath right ear; at first slow growing; 3 days before admission increased enormously in volume; projected into mouth between palatal arches and interferred with both deglutition and respiration; indistinctly fluctuating; intra-orally no pulsation; punctured for an abscess, with gush of blood instead of pus escaping; hole closed with hairlip pins and twisted silk; next day, artery ligated; 13 days after operation, hemorrhage from neck, repeated six times; patient died, Nov. 5, 1841, in collapse; necropsy: aneurysm extracranial part internal carotid artery.
2	Postempski: Riforma med. 6: (Part 1) 479, 1890	.. L	.....	Ligation common carotid artery and incision of sac, 1890	Yes	.....	Patient seen a month prior, had false aneurysm, complicating an abscessed tonsil; postoperative course uneventful; case reported at meeting of Association of Italian Surgeons, Florence, 1890
3	Bartlett, in Heaton: Birmingham M. Rev. 30: 304, 1891	♂ 20 L	10 days	Ligation common carotid artery, 7/3/1890	....	Yes, July 6, 1890; hemorrhage	Quinsy, June 23, 1890; 3 days before admission, profuse hemorrhage from mouth and nose, controlled by nasal packing; repeated, July 2 and 3, with some oozing from ear also; July 2, swelling noticed in left parotid region; taken for an inflamed gland; on admission, blood trickling from left ear and nostrils; large ill defined swelling in left side of neck, pulsating in unison with heart; mouth could be opened only with difficulty; left tonsil, pushed across midline; swelling soft and fluctuated; mucous membrane, tense and shiny and pulsated synchronously with swelling on outside and in expansile manner; no bruit or thrill; all pulsation arrested by pressure on common carotid; during induction of anesthesia breathing ceased, for which Haslam did a tracheotomy; all pulsation ceased after artery was tied; aneurysm shrank considerably, but patient died, July 6; necropsy: aneurysm internal carotid artery which had ruptured into mouth
4	Wulff: München med. Wchnschr. 47: 687, 1900	♀ 8 L	2 months	Ligation common carotid artery, 2/4/1900	Yes	.....	Follicular tonsillitis; shortly thereafter swelling in left tonsillar region; lanced with the recovery of blood only; middle of January, 1900, lump in throat, pulsating to both sight and touch; suspecting aneurysm, author inserted a needle; blood only aspirated; at first treated by compression, but without success; after ligation all motion in sac ceased, never to return, but clot in sac eventually suppurated, necessitating incision
5	Zamboni, in del Fabro: 13th Cong. int. de med., Paris, sect. de chir. gén. 10: 516, 1900	♀ 60 R	3 years	Ligation internal carotid artery, 1900	Yes	.....	No history of syphilis; influenza 3 years before, month later sensation of a lump in throat, oppressed breathing, hoarseness; one year prior to admission, noticed mass in throat; dysphagia; fever; vertigo; unconsciousness; convulsions; condition diagnosed abscess; incision advised but rejected by patient; became worse; needle inserted and blood aspirated; as needle tract continued to trickle blood, patient visited author, who could discover nothing abnormal except roundish tumor in right tonsillar region; uvula pushed well to left; pulsation visible; finger in mouth felt round, stiff, elastic, smooth, fluctuating and strongly pulsating mass which caused muffling of voice; diagnosis, aneurysm; patient experienced no inconvenience from ligation; 2 months later tumor was reduced in volume, sac firm, voice clear and deglutition improved

6	Bruns, in Blauel: Beitr. z. klin. Chir. 39 : 620, 1903	♀ 58 L	10 years	Ligation and division common carotid artery, 12/16/1902; ligation internal and external carotid arteries, extirpation of sac, 4/4/1903	Yes	.....	Ten years before, patient noticed slowly growing lump in left side of neck, which 4 weeks previous to admission had begun to increase rapidly in size; mouth opened with difficulty; dysphagia; dyspnea; pain; paralysis of the left hypoglossal and recurrent laryngeal nerves; Dec. 14, 1902, suddenly ceased breathing; for resuscitation tracheotomy done; no ill effects from ligation of common carotid; lump became smaller; no reappearance of pulse, but dysphagia persisted, so second operation was done; April 4, 1903, hoarseness unchanged; hypoglossal still paralyzed; no swelling inside or outside throat; no bruit or pulsation; originally, there was a swelling, both internally and externally; bruit and expansile pulsation synchronous with the beats of the arteries
7	Helman: Yezhemies. Ushn., Gorlov. i Nosov. Boliezn. 6 : 75, 1911; also Medycynai. kronika lekarska 44 : 681, 706, 1909	♀ 56 R	1 year	Ligation common carotid artery, about 1910	.....	Yes; pneumonia	Sensation of foreign body in right side of throat for a year with no pain, dysphagia or difficulty in speaking; on inspection, spheroidal tumor, with smooth, glistening surface pushing right tonsil quite to uvula; at first glance would have been mistaken for peritonsillar abscess, but its long duration, absence of pain, and lack of inflammatory signs were against such a diagnosis; besides swelling was actively pulsating, movements being rhythmical with radial pulse; she had had tinnitus in right ear; accordingly, diagnosis was made of aneurysm of one of carotids, most likely internal; a colleague suggested that a trocar be inserted to verify diagnosis, a procedure which Helman deemed neither expedient nor safe; ligation of common carotid advised, but rejected by patient; loud murmur corresponding in time to heart beat heard; blow much diminished by pressing on common carotid; given potassium iodid; Helman learned several months later that patient had undergone operation at Warsaw and an aneurysm of internal carotid artery had been found; according to Helman, a colleague in dispensary had almost opened this aneurysm for abscess; he had sent the woman to clinic for demonstration, having advised her to return for puncture; as patient gave history of sore throat some months before, author believed it of erosive rather than spontaneous origin
8	Marschik, in Klarfeld: Wien. klin. Wchnschr. 28 : 1361, 1915	♂ 18 L	7 days	Ligation common carotid artery and internal jugular vein	....	Yes; 12 hours after operation, sepsis, exhaustion, hemorrhage	Occurred in course of acute bilateral tonsillitis; high fever; large mass under angle of left jaw; on seventh day profuse hemorrhage from mouth, necessitating ligation of carotid artery; as internal jugular vein was injured in course of operation, it was likewise tied and resected; necropsy: aneurysm of internal carotid artery
9	Ransohoff: Ann. Surg. 68 : 152, 1918	♀ 16 L	1 week	Ligation common carotid artery, 1/20/1918	Yes	.....	Had had septic sore throat; left submixillary glands suppurated and were lanced eight days before admission; hemorrhage from drainage tract, 3 days before, repeated day of entrance, Jan. 20, 1918; immediately put under gas and glands removed; when throat was examined, it was found that hemorrhage was from aneurysm of internal carotid; swelling in left pharyngeal wall as large as a peach, elastic and pulsating; compression of common carotid caused pulse to disappear; after the girl was returned to bed, marked dyspnea arose from pressure of hematoma on larynx necessitating a precautionary tracheotomy; 3 months later she was perfectly well; there had been no return of pulse in temporal artery

TABLE 8.—*Erosive Aneurysms Not Operated On*

Case	Author and Reference	Sex; Age; Side	Duration	Cured	Died; Cause	Remarks
10	Neuffer: Ztschr. f. Wundärtze u. Geburtsh. 4: 206, 1852	♂ 13 L	.....	....	Yes, in 2 days; hemorrhage	Had had angina tonsillaris in fall of 1851; food passage narrowed; dysphagia; as disease progressed jaws became fixed and could scarcely be opened; external remedies employed futilely and on twelfth day of disease patient had profuse hemorrhage from mouth; repeated on the thirteenth day, with fatal ending; necropsy: aneurysm of internal carotid with opening into mouth
11	Lyot and Petit: Gaz. méd. de Paris 1: 159, 1897	♀ 19 L	1½ months	Yes; spontaneous	.....	Had had scarlet fever complicated by severe inflammation of throat, and later walnut sized growth that pulsated energetically, but could be emptied by compression; on puncture, pure blood obtained; though patient received no treatment, lump had about disappeared in 3 months; symptoms; lump both on inside and outside of pharynx; expansile pulsation; dysphagia; elastic uniform consistency; aspiration of blood; reduction in size by pressure on carotid; systolic bruit, would seem to clinch diagnosis; ligation not done on account of the poor condition of patient
12	Johnson: Tr. Am. Laryngol., Rhinol. & Otol. Soc. 7: 226, 1910	♂ 4 L	10 days	....	Yes; 5 months hemorrhage	Gave history of sore throat for 10 days, fever, pain, and swelling in tonsillar region; had been seen by number of physicians, most of whom believed condition a peritonsillar abscess; incision contemplated, but not undertaken on account of unruliness of patient; midwife had even attempted to scratch hole in it with finger nail; soon ear began to discharge; first seen by Johnson, March 15, 1900, in consultation with another physician who thought swelling an abscess; auditory canal now completely filled by pulsating mass; also present a tense swelling in upper part of neck in which no pulsation could be seen or felt or bruit heard; internally, a tumor occupying left tonsillar region, tense, red and easily compressible; diagnosis: aneurysm of internal carotid; patient not seen again until June 11; patient now dyspneic, drowsy, stupid; mass much larger; tonsil removed and tracheotomy done; child did fairly well until Sept. 7, 1900, when sac ruptured into mouth and continued to ooze until September 11, when child died
13	Velebil: Casop. lék. cesk. 52: 976, 1913	♂ 2½ R	.....	....	Yes, June 13, 1909; hemorrhage from puncture	Brought to hospital, June 13, 1909, for dyspnea and dysphagia; on examination, found bulging, fluctuating mass in oropharynx which was taken for an abscess; swelling bluntly punctured with forceps; instead of pus escaping, stream of blood spurted out through mouth and nose; packing proved futile and child died in few minutes; necropsy showed right suppurative otitis media, right purulent mastoiditis with necrosis in vicinity of carotid canal, aneurysm of internal carotid in neck, with stoma into mouth; on pressure yellowish exudate was forced out of crypts of slightly hypertrophied tonsils; cervical glands swollen and hard; no cause assigned by author, but probably erosive

14	Hirsch: Monatschr. f. Ohrenh. **48**: 780, 1914	♂ 6 L	3 years	....	Yes; on the operating table, from anesthetic (chloroform)	Following attack of scarlet fever, bleeding from mouth and ear; below left ear firm, elastic tumor, size of child's fist; internally, mass springing from left pharyngeal wall and extending to midline; Hirsch attributed condition to middle ear disease and had decided to do a radical mastoidectomy; while going under anesthesia child ceased breathing; rapid laryngotomy of no avail; no reason assigned for lesion; no Wassermann test permitted; fearing necropsy would not be permitted author made incision in neck; aneurysm of internal carotid discovered
15	Vas: Jahrb. f. Kinderh. **83**: 493, 1916	♂ 11 mo. L	3 weeks	....	Yes; incised for abscess, died shortly thereafter	When seen in May, 1913, child had had scarlet fever for 3 weeks and for some days increasing dysphagia and dyspnea; diffuse, palpable, child's fist sized swelling in left side of neck; head inclined to right and backward; throat deeply injected but without visible arching; deep in left retropharyngeal region, fluctuating mass size of hazelnut; diagnosis, abscess; as symptoms were pressing, incision was made with recovery first of bloody mucus, then of pure blood; finger inserted to control hemorrhage and tracheotomy done, preliminary to proposed ligation of common carotid, but child died before any arterial surgery could be accomplished; necropsy showed aneurysm of internal carotid with an ostium in ist pharyngeal wall; supposition was lesion was consecutive to cervical adenitis, the toxins of which had softened walls of diseased vessel
16	Beck: Monatschr. f. Ohrenh. u. Laryngo-Rhinol. **52**: 606, 1918	♂ 20 L	.....	....	Yes; repeated hemorrhages from spontaneous rupture	Soldier, never at front, May 12, 1917, without ascertainable cause, had profuse hemorrhage from nose and mouth; arrested with tampons; on their removal next day there was active bleeding for which man was transferred to care of Beck; examination of throat revealed only few raw spots in mucous membrane of left side; May 17, 1917, uncontrollable hemorrhage occurred and man died forthwith; necropsy showed aneurysm of internal carotid artery, size of walnut and fused with tuberculous gland; in oropharynx was cloaca, plugged with clot that communicated with aneurysmal sac; in spite of size of aneurysm no bulging in pharyngeal wall; failure of aneurysm to point in throat ascribed to its being forced backward by contracting lymphatic gland; overlooking of pulsation attributed to same cause; diagnosis made at necropsy
17	Pusateri: Policlinico, sez. prat. **25**: 475, 1918	♂ 38 R	....	....	Yes; 6½ months after onset from hemorrhage	Soldier, May 8, 1917, introduced nitric acid into right ear; 17 days later facial paralysis developed, and 8 days later he had nosebleed; night of November 25-26, profuse hemorrhage caused death; necropsy: aneurysm of internal carotid and similar condition in internal jugular vein, both of which had burst; also purulent meningitis; condition not recognized until necropsy; case illustrates danger of inflammation extending through bony walls of ear and so weakening walls of contiguous vessels as to permit formation of aneurysm
18	Schlagenhaufer: Zentralbl. f. allg. Path. u. path. Anat. **29**: 423, 1918-1919	♂ 48 R	.....	....	Yes; 4 days after incision for suppurating lymph glands	October, 1916, patient was taken with pain in right side of neck and dysphagia; February, 1917, right side of neck began to swell; April 6, 1917, diagnosed abscess and incised; only on escape of thick stream of blood did operator realize nature of malady; gauze tampons used to still hemorrhage; necropsy: aneurysm of internal carotid artery just above its origin; soft tissues bathed with purulent secretion

which was in turn succeeded by an energetically pulsating lump. The mass collapsed on compression of the common carotid artery and on puncture furnished pure blood. Though the patient received no treatment, the swelling diminished to the vanishing point in three months. Ligation of the internal carotid artery was considered but rejected on account of the poor condition of the patient.

The most striking feature in this group of cases is the extreme youthfulness of the patients, twelve being recorded as under 21 years of age. This is a matter of no little practical significance, as peritonsillar abscess is a very common disease in young people. That treatment appropriate to the latter may lead to grave consequences if applied to the former is strikingly attested by the death of four of these patients. Wulff was spared this embarrassment by ligating the common carotid artery, but Liston, Vas, Velebil and Schlagenhaufer were not so fortunate. Helman under similar circumstances changed the diagnosis of a colleague from abscess to aneurysm. This patient was later operated on at another clinic, but died of a postoperative pneumonia. Zamboni saw a case that others had diagnosed as abscess and advised incision. He recognized the nature of the affection, ligated the internal carotid artery and saved the patient's life. On the other hand, the proclivity of this aneurysm to spontaneous rupture has led to equally disastrous consequences by the physician in charge failing to recognize its nature. A case in point is that of Neuffer. The patient had had an angina tonsillaris, followed by an increasing enlargement of the left tonsil. As the disease progressed the food passage became so narrowed as to prevent the swallowing of solids and the jaws could be opened only a slight distance. On the twelfth day of the disease the patient had a profuse hemorrhage from the mouth with a fatal repetition the next day. The source of the hemorrhage remained in doubt until necropsy revealed an aneurysm of the internal carotid with an opening into the mouth. Among others Johnson lost a patient under quite similar circumstances. In view of the catastrophes mentioned in the foregoing the prompt recognition of fauceal aneurysm consecutive to scarlet fever, influenza, cervical adenitis, septic sore throat and inflammatory tonsillar disease is of the utmost importance, as a false move may jeopardize the safety of the patient's life.

In addition to the cases tabulated, Molinié [15] cites the following suggestive case. The patient, a woman, who had suffered with an otitis media from infancy, underwent an operation in 1898, evidently for mastoiditis. In 1905, a second operation was interrupted by the occurrence of a profuse hemorrhage, which was controlled by packing the

15. Molinié: Rev. de laryngol., d'otol et de rhinol. **13**:97, 1921; abstr. by Bourgeois: J. de chir. **18**:254, 1921.

wound with gauze. Ultimately the cavity filled up with a dark red tumor from which, without apparent reason, two hemorrhages occurred. The lump pulsated neither to sight nor to touch unless compressed when an indistinct pulsation was both seen and felt. In 1906, paralysis of the facial nerve developed and in 1920, of the auditory, the glossopharyngeal, the pneumogastric and the spinal accessory. Molinié at first regarded the lesion as an arterial or an arteriovenous aneurysm, but later discarded this diagnosis in favor of dilatation of the lateral sinus and bulb of the internal jugular vein, ascribing the pulsation to transmission of the cerebral pulse. Another doubtful case is that reported by Majewski.[16]

The patient, a man, aged 64, complained of a pain in his neck of three weeks' duration, and for two weeks he had had a swelling in the left side of the neck. The overlying skin was neither raised nor red. The lump was opened under ethyl chlorid applied locally, and a small amount of whitish exudate was evacuated. Eight days later blood escaped from the wound. This was arrested by tampons. On the eleventh day during the process of redressing there was a repetition of the bleeding. Again tampons staunched the flow of blood. Three days later there was a renewal of the bleeding. This time the flow could not be stopped by pressure, so the patient was taken into the hospital, where an incision was made through the previous operative site. The hemorrhage was now found to be deep seated. First, the internal carotid artery was tied near its origin, but as the bleeding continued, the vessel was still further exposed and a rent from which the blood was pouring was disclosed. A second ligature was placed above this point. The bleeding now stopped, but the day following there was some elevation of temperature, a pulse rate of 120, and a fully developed hemiplegia. Death occurred thirty-six hours after the operation. Helman[17] refers to two cases of large vascular pharyngeal enlargements reported by Stoerck[18] as hematomas from which when opened a profuse hemorrhage flowed, the arrest of which proved exceedingly difficult. From the description Helman says that it is extremely difficult to judge whether these were aneurysms or inflammatory swellings with bloody contents. This author also mentions that in 1895 Grossmann showed a case of aneurysm of the throat successfully treated by ligation of the common carotid artery before the Vienna Laryngologic Society. Schulte[19] reports the following case:

A woman, aged 26, consulted him, Oct. 8, 1903, for a running from the ear which she had had off and on for many years. On examination Schulte discovered a superficially smooth, bluish red growth which he took for a polypus

16. Majewski: Kron. lek. **24**:658, 1903.
17. Helman: Medycyna i. Kron. lek. **44**:685, 1909.
18. Stoerck: Nothnagel's Special Pathology **13.**
19. Schulte: Monatschr. f. Ohrenh. **38**:117, 1904.

projecting through a rent in the ear drum. He incised this and was rewarded with the escape of a strong stream of bright red blood. The flow was brought partially under control by gauze packs and the diagnosis changed to aneurysm of the internal carotid artery. As from time to time there was a renewal of the bleeding, Dr. Schneider made a ligation of the common carotid artery, October 11, apparently with success; but the next day the bleeding recurred and did so daily until October 15, when a solution of gelatin was injected into the patient. There was no further bleeding until October 26, then a daily repetition to October 30, and from then to November 18, intermittently, when following a total of nineteen injections of gelatin, the hemorrhage finally ceased. The patient was discharged, December 14, as cured.

Hirsch [20] states that Heine found an aneurysm of the internal carotid artery in a 53 year old man. Concerning the further course of the case he could add nothing. This is in all probability the same case that Heine [21] reports under the title of bleeding from the internal carotid artery in consequence of erosion.

A woman, aged 56, was admitted to the hospital, Feb. 13, 1900. At 3 years of age she noticed a swelling behind the right ear. This opened at the age of 6 and discharged for fifteen years. Pain was first felt in August, 1899, and some days later a right hemicrania developed. At the base of the right mastoid process was a fistula filled with a bad smelling mass. February 16, a radical mastoidectomy was done and the patient was discharged April 14, with the wound still running. She was readmitted August 27, and the wound was curetted the same day. During the maneuvers the carotid artery was exposed. To the sight it did not pulsate. At the change of dressings, September 1, a stream of dark blood suddenly escaped. Pressure on the common carotid did not influence the flow. Arrest of the hemorrhage was finally accomplished by iodoform gauze tampons. He attributed the hemorrhage to an erosion of the internal jugular vein. The bleeding recurred several times thereafter, but was easily controlled by pressure. The woman, however, did badly and died, October 1. Necropsy showed that the blood had come from an erosion of the internal carotid artery superinduced by middle ear disease, and death was caused by sepsis.

Benjamins [22] records a case of aneurysm of the right internal carotid artery with fatal bleeding from the external auditory meatus from necrosis of the floor of the canal following the insufflation of powdered arsenic for the cure of a discharge. The patient, a woman, fell into Benjamins' hands shortly after, but died. Necropsy revealed an aneurysm of the internal carotid, but I could not determine whether it was in the extracranial portion of the vessel or in the bony canal. Certainly there were no pharyngeal symptoms. At the time of the hemorrhage Benjamins believed the source of the bleeding an eroded

20. Hirsch: Monatschr. f. Ohrenh. u. Laryngo-Rhinol. **48**:782, 1914.

21. Heine: Berl. klin. Wchnschr. **38**:619, 1901.

22. Benjamins: Arch. f. Ohrenh. **76**:240, 1908.

jugular vein because pressure on the common carotid artery failed to stop the hemorrhage. Quite a similar case is that of Ruttin.[23]

A soldier was admitted to the hospital, Jan. 17, 1918, for bleeding from the left ear, nose and mouth. In November, 1917, while serving on the Italian front, he was buried by the explosion of a shell. Since 1914, he had had a discharging left ear which was rendered worse by the accident. On entrance the left ear was discharging a quantity of foul pus and the patient complained of severe pain in the head. After admission the hemorrhage from the nose, mouth and ear renewed itself on several occasions. Jan. 18, 1918, a radical mastoid operation was undertaken. January 20, there was renewed bleeding from the mouth and nose, and the man died. Necropsy showed the presence of an aneurysm of the internal carotid artery in the knee of the carotid canal, the wall of which was eroded.

Ehrmann[24] of Mulhouse reports the following suggestive case:

A man, aged 22, entered the hospital, April 28, 1875, in the service of Dr. Battenburg, for an angina tonsillaris of a few days' duration which had localized on the right side. He complained of pain in the right submaxillary region, dysphagia and fever. May 1, the abscess opened spontaneously into the throat, at which time a stream of red blood flooded the mouth. This ceased spontaneously, but a few hours later a new hemorrhage occurred. It was as sudden in onset as the first, but less abundant. Inspection of the throat, which was accomplished with difficulty owing to the locking of the jaws, revealed redness, edema and tumefaction of the velum, and a distinct impulse was imparted to a palpating finger. Soon there was a repetition of the bleeding but on a grander scale. The patient was now in a state of syncope, quite exsanguinated with a thready pulse and cold extremities. Delay was no longer permissible, so Ehrmann, with the assistance of Battenburg, made a ligation of the common carotid artery. On account of the size of the swelling the vessel had to be ligated below the omohyoid muscle. The postoperative course was favorable. At no time were there any cerebral or nervous symptoms. The patient was discharged cured, June 18, 1875. Ehrmann considered this a case of erosion on the internal carotid artery.

TRAUMATIC TYPE

A striking feature of this series is the relatively large number of aneurysms of this vessel reported as following gunshot wounds incurred either in the Balkan or the World Wars. As a result of these struggles fourteen case reports have found their way into print, whereas so far as I could determine the internal carotid artery had escaped this lesion in previous wars. This immunity has been explained by the blunter shape of the bullets in former days and the slower speed at which they traveled. On the other hand, most of the cases occurring in civil practice have been the result of knife or puncture wounds. No matter how produced, traumatic aneurysm of the internal carotid artery has the same

23. Ruttin: Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres **11**:224, 1919.
24. Ehrmann: Bull. et mém. Soc. de chir. de Paris **55**:664, 1878.

practical interest to the surgeon and the physician as the types already discussed, for like them it has on occasion been mistaken for abscess and has been lanced, with unfortunate results. Of no less importance is the tendency of this aneurysm if left untreated to rupture spontaneously with the premature death of the patient. Of the treated patients a fair proportion are saved; in the untreated, an exceedingly high mortality rate is to be expected.

The patients numbered twenty-seven, of which thirteen, or 48.15 per cent., recovered; thirteen, or 48.15 per cent., died, and one, or 3.7 per cent., was discharged unimproved. Twenty-five were males; one was a female. In one the sex was not mentioned. The ages ranged between 6 and 37 years, respectively, thirteen being 17 years or over, two less than 17; in nine cases the patients were described as soldiers and in one as a sailor. Presumably, the latter were young adults. In one no clew to the age was given. A noticeable feature of this series is the comparative youth of the victims. As one would naturally suppose from males being more exposed to injury, the men far outnumber the women, being in the proportion 25:1. Twenty-one were operated on, with thirteen, or 61.91 per cent., cures; and eight, or 38.09 per cent., deaths (Table 9). Six patients were not operated on, with five, or 83.33 per cent., deaths; the other, Orth's patient, refused operation, passed from under his care and was presumably lost sight of as no mention was made of the ultimate outcome (Table 10). The right side was affected fifteen times; the left, six. In six instances the side on which the lesion was located was not mentioned. The aneurysm was attributed to puncture wound once; to stab wound, four times; to pistol or bullet wound, nine times; to missile wound, once; to shell splinter, twice; to severe injury received two years before in a bicycle collision, once. The cause of seven was not mentioned. Six of the latter were soldiers, and the probability is that in these the primary injury was a gunshot wound. The deaths in the operative cases were assigned to cerebral softening three times; to sepsis, once; to softening of the brain and pneumonia, once; to the closing of wound on operating table, once; to secondary hemorrhage, once. The nonoperative deaths were attributed to spontaneous hemorrhage twice; to uncontrollable hemorrhage when aneurysm was mistaken for abscess and lanced, once; to thrombosis of vertebral artery, once; to softening of the brain, once.

The vessels ligated and the results were as follows: common carotid artery, nine times, with four cures and five deaths; common and internal carotid arteries, above and below sac, with opening of the sac, once, with cure; common, external and internal carotid arteries and superior thyroid artery, extirpation of sac, once, with cure; common carotid artery and internal jugular vein, once, with cure; common carotid and internal

carotid arteries, once, with cure; common carotid artery, incision and packing of sac, twice, with two cures; common carotid, later external and internal carotid arteries, once, with cure; internal carotid artery, twice, with one recovery and one death; internal carotid artery, above and below sac, extirpation of sac, once, with death; internal carotid artery, suture of proximal segment and double ligation of internal jugular vein, once, with cure; internal carotid artery, above sac, common carotid, below, and internal jugular vein, once, with cure.

Lee fifteen days after the accident noticed a swelling in the hard and soft palate which he mistook for an abscess; he lanced it and was surprised with a gush of bright red arterial blood, accompanied by a peculiar noise. All attempts to stem the flow were prevented by the struggles of the patient, who died in a few minutes. Booth's patient was seen by a number of physicians, most of whom were inclined to the diagnosis of peritonsillar abscess. There never was any apparent pulsation in the lesion, which was hard and firm to touch. A profuse, spontaneous hemorrhage proved fatal in a few minutes.

The story of traumatic aneurysm in the cervical portion of the internal carotid artery would be incomplete were the following cases passed by in silence. The reports themselves will indicate the reason for their deletion. The nature of the case reported by Matas,[25] and cited as a possible example of extracranial aneurysm of the internal carotid artery, is no longer in doubt. March 11, 1924, Matas [26] said:

> I notice that you refer to my early case of suspected aneurysm of the internal carotid artery. In this case the death of the patient about a year after my report cleared all doubt. The patient returned with a decided increase in the tumor with secondary growths in the corresponding cervical glands. After preliminary tracheotomy, I made an attempt to extirpate the mass, which projected into the pharynx. The patient survived the operation only a few weeks. The tumor proved to be a fibrosarcoma. There is no question that in this case there was no aneurysm, though the clinical history and symptomatology simulated an aneurysm so closely that there was always a doubt as to the true nature of the tumor until the final outcome proved unequivocally that it was not. However, you will agree that in the case that I reported Logan and Souchon had good reasons for their diagnosis.

It is only fair to Matas to state that from the beginning he believed the case a fibro-adenoma of the tonsil, but his colleagues, Logan and Souchon, were as firmly convinced as to its aneurysmal nature. As most of the mistakes in diagnosis have been in the opposite direction the history of this case is worthy of relating. The patient, a man, aged 35, had had an inflammation of the throat simulating an abscess six years before. This was punctured by a local physician, but without result.

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25. Matas, Rudolph: New Orleans M. & S. J. **22**:245, 1894-1895.
26. Matas, Rudolph: Personal communication to author.

TABLE 9.—*Traumatic Aneurysms Operated On*

Case	Author and Reference	Sex; Age; Side	Duration	Operation Date	Cured	Died; Cause	Remarks
1	Mettauer: Am. J. M. Sc. **18**: 351, 1849	♂ 25 R	6 weeks	Ligation common carotid artery, 3/8/1842	....	Yes, 12 days after operation; softening of right hemisphere	Puncture wound; day after operation paralyzed in left leg and arm; gradually grew worse until death; necropsy
2	Briggs: Nashville J. Med. & Surg. **7**: 402, 1871	♂ 23 L	6 weeks	Ligation common and internal carotid arteries, 2/23/1871	Yes	.....	Stab wound, middle of January, 1871; admitted, February 8, for a circumscribed, smooth, strongly pulsating, expansile swelling in left parotid region; bruit; lump in throat; dysphagia; volume lessened by pressure to common carotid artery; compression used to no avail, the mass enlarging daily; patient alive and well in 1886
3	Prewitt: Tr. Am. S. A. **4**: 233, 1886	♀ 17 R	4 months	Ligation common carotid artery; tube drainage, 4/4/1885	....	Yes, 25 days after operation; sepsis; thrombosis right lateral and inferior petrosal sinuses	Bullet wound in married negress; increasing pharyngeal swelling, pulsating in every direction; thrill; bruit; projecting externally behind jaw; paralysis of pharyngeal muscles; loss of taste right half of tongue; pain in head and neck; headache; roaring in right ear; muffled voice; dysphagia; pulsation controlled by compressing common carotid; 8 days after operation bleeding from external wall of sac; repeated following days, so sac was incised and its cavity packed with gauze; bleeding arrested; convulsions on the twenty-third day, repeated until death; necropsy: bullet found in sac
4	Duchamp: Loire méd. **17**: 113, 1891	♂ 32 R	8 days	Ligation common carotid artery, 8/27/1891; ligation external and internal carotid arteries, 9/5/1891	Yes	.....	Admitted, Aug. 20, 1891, for a pistol wound; there was slight swelling but no pulsation; at end of 8 days, swelling had taken on appearance of an abscess, but pulsation was discernible to both sight and touch and was arrested by pressure on common carotid, which indicated clearly its nature; situation was dangerous, especially as patient had had several slight hemorrhages from mouth; with tying of knot pulsation ceased immediately, to return 3 days later, rendering a second intervention imperative; after completion of latter operation, patient's mouth was opened to view result; there was spurt of blood from orifice of bullet; a finger was inserted into rent until it could be plugged with gauze; no further bleeding occurred; patient was alive 7 years later
5	Ciechomski, in Lewenstern: Gaz. lek. **21**: 658, 1901	♂ 29 R	1 day	Ligation common carotid artery, 8/20/1897	Yes	.....	Cut with knife in August, 1897, following day at site of injury an increasing hematoma appeared which interferred with speech; 14 days later patient admitted to hospital, for an expansile swelling in parotidean region, evident to both sight and touch, hard and painful and of such volume as to cause disfigurement; slight thrill present; muscles supplied by facial, hypoglossal and recurrent laryngeal nerves paralyzed; pulsation arrested by compressing common carotid; right tonsil was pushed inward to midline, red and swollen; mass soft, pulsating and expansile; dysphagia; spoke in a whisper; diagnosis: aneurysm internal carotid; with tying of ligature, all motion in mass ceased; swelling gradually subsided; swallowing became possible and voice returned; 3 years later patient was in good health; no evidence of the aneurysm
6	Bobbio: Policlinico, sez chir. **13**: 50, 1906	♂ 20 L	1 day	Ligation common carotid artery, 3/8/1904	Yes	.....	Knife wound, left side of neck, Jan. 18, 1904; almost complete loss of voice; large subcutaneous cervicofacial hemorrhage; laryngeal stenosis; voice husky, almost aphonic; dyspnea; paralysis left vocal cord and left side of tongue; tonsil pushed inward to median line by bulging of pharyngeal wall; February 24, patient felt pulsation in submaxillary region; bimanual examination showed fluctuating and compressible tumor; on compression of carotid, pulsation disappeared and mass was noticeably diminished in volume; with ligation pulsation ceased; when discharged there was no detectable pulsation, but nervous phenomena persisted

7	Gjurjevitch, in Subbotitch: Deutsch. Ztschr. f. Chir. **127**: 462, 1914	♂ Soldier	.....	Ligation internal carotid artery, about 1913	....	Yes, in 4 days; softening of brain and pneumonia	Article is lacking in details; patient was Serbian soldier wounded in Balkan War, 1912-1913; immediately after operation patient lost consciousness; then pneumonia developed; necropsy
8	Morestin: Bull. et mém. Soc. de clin. de Paris **41**: 2443, 1915	♂ 35 L	5 months	Ligation internal carotid artery and extirpation of sac, 5/9/1915	....	Yes, in 36 hours; hemiplegia from embolus	Soldier, wounded by bullet in battle, June 25, 1914; on admission pulsating tumor high up in left side of neck; integument thin but intact; pulsation expansile; mass slightly reducible on pressure; bruit; paralysis of left sternocleidomastoid and trapezius muscles, left half of tongue and left vocal cord; no immediate signs of intracranial mischief on day following epileptiform seizure and right hemiplegia; condition gradually grew worse until death; no necropsy
9	Page, in Makins: Brit. J. Surg. **3**: 378, 404, 1915-1916	♂ Soldier	5 days	Ligation common carotid artery	Yes	.....	Missile injury received in World War; patient presented tense swelling of soft palate, which gradually faded away after ligation; tying of artery caused no cerebral symptoms; there was a right facial weakness
10	Bouchard: Rev. gén. de clin. et de thérap. **30**: 104, 1916	♂ Soldier R	15 days	Ligation common carotid artery, 6/6/1915	Yes	.....	Soldier received pistol wound in 1915; apparently making smooth recovery when, June 6, he had a severe hemorrhage from wound; at no time were there any cerebral symptoms
11	Kalima: Finska läk. sällsk. **58**: 1041, 1916	♂ 19 R	.....	Ligation common, external, internal carotids, superior thyroid arteries and internal jugular vein, with extirpation of the sac, 7/3/1916	Yes	.....	A soldier was admitted, June 23, 1916, for a shell wound in upper right cervical region, where there was diffuse swelling; July 21, was convalescing nicely
12	Pribram: Arch f. klin. Chir. **108**: 680, 1917	♂ Soldier	.....	Ligation common carotid artery	....	Yes, on third day; cerebral softening	Paralysis appeared on side opposite wound day following operation; necropsy
13	Pribram: Arch. f. klin. Chir. **108**: 680, 1917	♂ 28 R	1 month	Ligation internal carotid artery, 12/11/1916	Yes	.....	Turkish soldier wounded by shell splinter, Oct. 14, 1916; right sided paralysis of facial, glossopharyngeal and hypoglossal nerves; severe pain in ear and neck; pulsating swelling with systolic blow; dysphagia; pharyngeal swelling size of walnut; it had all appearances of retropharyngeal abscess; during succeeding days symptoms became more aggravated and with pulsation and thrill led to diagnosis of aneurysm of internal carotid; at no time was there pain or cerebral disturbances; 2 months after operation he was quite well, and paralysis had disappeared
14	Pribram: Arch. f. klin. Chir. **108**: 680, 1917	♂ Soldier	.....	Ligation common carotid artery	....	Yes, in 10 days; cerebral softening	After ligation patient did nicely for 4 days, then flaccid paralysis supervened in leg and arm of side opposite injury; necropsy
15	Gilberti: Policlinico, sez. prat. **25**: 557, 1918	♂ 23 R	Short time	Ligation internal and common carotid arteries and internal jugular vein, 6/30/1917	Yes	.....	Shrapnel wound received June 20, 1917; right side of neck seat of tumefaction, size of apple; dysphagia, hoarseness; dyspnea; cyanosis; lump soft and compressible and pulsated synchronously with opposite carotid; mass pulsatile throughout; paralysis of right side of soft palate, of tongue and of right vocal cord; sac found at operation to arise from internal carotid just above bifurcation; at end of 2 months paralysis had disappeared with exception of slight deviation of tongue to right
16	Rauchenbichler: Arch. f. klin. Chir. **110**: 700, 1918	♂ Soldier R	2 weeks	Suture of proximal segment of internal carotid artery and ligation internal jugular vein, 11/6/1916	....	Yes, on table while wound was being closed	Wounded, Sept. 29, 1916; no swelling in neck or throat, no pulsation, no bruit; movements of jaw unimpaired; speech indistinct; incomplete paralysis of left upper extremity, complete of left lower; October 25, wound in neck suppurated, reopened and drained; October 31, spontaneous hemorrhage, cause a mystery; temperature now septic and jaws locked; November 5, small, tender, puffy area showed in neck; November 6, bruit detectable; diagnosis made at operation; vessel had been completely severed; necropsy revealed organizing clot in cerebral end of internal carotid and softening of brain

TABLE 9.—*Traumatic Aneurysms Operated On—(Continued)*

Case	Author and Reference	Sex; Age; Side	Duration	Operation Date	Cured	Died; Cause	Remarks
17	Sanders: J. Roy. M. Service 5:101, 1919	♂ Man R	1 week	Ligation common carotid artery, 6/20/1917	....	Yes, in 14 days; hemorrhage from rupture of sac	Bullet wound, right side of neck, June 13, 1917, causing hematoma; fifth day pulsation noticed and thought to be expansile, and soft systolic blow audible; soon aneurysm definitely increasing in size; patient's condition daily becoming worse; 4 days after operation some return of pulsation; on fourteenth day lower end of sac burst into wound; although bleeding was promptly stemmed, patient died in 2¼ hours; necropsy: internal carotid severed at its origin; no suppuration in wound
18	Vegas: Rev. espan. de méd. y cirug. 3:381, 1920	♂ 6 L	1 year	Ligation common carotid artery and internal jugular vein, 4/16/1917	Yes	.....	Admitted, March 18, 1917, for pulsating lump in left side of neck consecutive to pistol wound; size of hen's egg, pulsated synchronously with radial artery and expanded throughout; bruit; slight thrill; diagnosis: aneurysm of internal carotid; March 18, right hemiplegia appeared, which was attributed to embolus; though patient had experienced paralytic stroke, indicated vessels were ligated; April 30 tumor had almost disappeared and paralysis was slowly improving
19	Caucci: Riforma med. 36:417, 1920	..	1 month	Ligation common carotid artery, incision and packing of aneurysmal cavity	Yes	.....	Knife wound; no cerebral symptoms; paper was presented before Societa Medico-Chirurgica Anconitana, Jan. 30, 1920; source given here was only an abstract and supplied no details of case
20	Official History of the Great War Medical Services, Surgery of the War, London, 1922, 2:243	♂ Soldier	.....	Ligation common and internal carotid arteries	Yes	.....	Hemorrhage from leaking aneurysm connected with commencement of internal carotid; no complications following operation
21	Camera: Minerva med. 2:720, 1922	♂ 8 R	1 month	Ligation common carotid artery, then accidental opening of sac during an attempted enucleation, enlargement of opening, extraction of coagula, free bright red hemorrhage controlled by packing, 4/23/1922	Yes	.....	Pistol wound received March 19, 1922, ball entering just below infra-orbital margin and lodging in upper part of right sternocleidomastoid muscle; patient first seen by Camera, April 19, 1922, for diffuse tumefaction of right cervical region situated in front of ear and extending from thyroid cartilage below to angle of jaw above; overlying skin thinned, and behind sternomastoid was open wound made 10 days after accident for purpose of extracting bullet which had been localized by roentgen ray; on admission patient looked ill; was dyspneic; could open mouth only 1.5 cm.; saliva drooled constantly; voice was husky; tongue when protruded, deviated to right and angle of mouth pulled to left; there was great displacement of right lateral pharyngeal wall which reached quite to median line; mass elastic in consistency; fluctuated; was slightly painful; harbored neither beats nor bruit; intra-oral palpation could not be made on account of inability of patient to open mouth; interference with swallowing; exploratory puncture had given exit to bright red blood; clinical impression was aneurysm in extracranial portion of internal carotid artery; postoperative course was uneventful and the patient was discharged as cured, May 25, 1922; at that time hypoglossal and vagal paralyses persisted; facial paresis was somewhat improved; patient was swallowing food without difficulty and pharyngeal swelling had receded to its normal limits

TABLE 10.—*Traumatic Aneurysms Not Operated On*

Case	Author and Reference	Sex; Age; Side	Duration	Cured	Died; Cause	Remarks
22	Fingerhuth: Preuss. Md. Zeitung 7 : 183, 1864	♂ 37 R	9 months	.....	Yes; hemorrhage, spontaneous rupture	Puncture of throat by stem of pipe; 5 days later pain in throat and stiffness of right side of neck; examination revealed puffiness in right parotidean region and red and swollen palate; swelling remained stationary for 8 months, then commenced to increase in size; finally hemorrhage from mouth which stopped spontaneously, to be followed 6 hours later by fatal bleeding; necropsy revealed aneurysm of internal carotid artery and close by missing piece of pipe stem
23	Lee, in Fenger and Lee: Gaillard's M. J. 35 : 10, 1882	♂ 28 R	15 days	.....	Yes, immediately; incised for abscess, with mortal hemorrhage	Bullet wound; subsequent swelling in right parotidean region; 15 days later swelling of hard and soft palates had appeared; aphonia, dysphagia and pain in right side of neck; with considerable difficulty patient succeeded in opening mouth sufficiently to permit limited inspection; tonsil and soft palate much swollen and on hard palate was small, firm tumor about size of hickory nut; thinking this the ball, Lee made incision; there was gush of blood which could not be brought under control; necropsy by Fenger revealed aneurysm of internal carotid artery
24	Booth: Philadelphia M. J. 6 : 1002, 1900	♂ 25 L	18 days	.....	Yes, in 10 days; hemorrhage	Trouble began Jan. 1, 1900; diagnosed as chronic quinsy, complicated by hemorrhage; when first seen by Booth, January 8, there was a mass in left tonsillar region extending to fauces; section from growth showed no signs of malignancy; never any apparent pulsation in lesion, which was hard and firm to touch; January 29, profuse hemorrhage, which proved fatal in few minutes; Booth considered case traumatic aneurysm consecutive to severe injury received two years before in bicycle collision while coasting; necropsy: aneurysm of internal carotid
25	Bier, in Kuettner: Beitr. z. klin. Chir. 108 : 6, 43, 1917	♂ 21 R	.....	.....	Yes, March 13, 1915; thrombosis of the circle of Willis, right and left internal carotids, etc.	Soldier wounded, Oct. 5, 1914, by gunshot projectile; tender swelling in left side of neck; roaring in ear; pulsation; no thrill; slight systolic bruit; March 12, 1915, Bier ligated left common carotid artery just below sac; as further freeing of primitive carotid failed to demonstrate the aneurysm as arising from it, he incised the sac and arrested the hemorrhage by introduction of finger; breathing suddenly ceased, but pulse retained good tone; after tracheotomy, breathing was reestablished, but patient failed to rally; necropsy; aneurysm of left vertebral artery, but what is of more interest, a penetrating wound of right internal carotid artery, on each side of which was aneurysm size of hazelnut and filled with firm clot
26	Orth: Beitr. z. klin. Chir. 105 : 347, 1917	♂ Soldier L	Some time	Unimproved	.....	Headache; neuralgia in neck and left side of head; patient could not be induced to undergo operation; further details wanting
27	Johnsen, in Gabriel: Beitr. z. klin. Chir. 116 : 583, 1919	♂ Soldier	1 month	.....	Yes; softening of brain	Wounded, July 2, 1918; Diagnosis, aneurysm of external carotid; August 23, vessel exposed, with failure to locate lesion; external carotid artery ligated, however; patient died same evening; necropsy revealed aneurysm of internal carotid artery and softening of brain

Examination revealed an intrabuccal and extrabuccal lump that pulsated strongly. The patient complained of dysphagia and his life was threatened by suffocation. An aneurysm of the right internal carotid artery was suspected, possibly of traumatic origin, and the corresponding common carotid artery was ligated at the point of election. The lump decreased in size but was persistent for two years. It did not pulsate. The man was improved in health. In view of the confusing nature of this case, its final disposition is a matter of no little interest.

An undoubtedly genuine case of traumatic aneurysm of the internal carotid artery, operated on by Bossowski and reported by Helman,[27] must be excluded from my list as neither the original article nor a transcript was accessible to me. Helman merely mentions the case without supplying any of the details. Rauchenbichler [28] describes a case that he clinically diagnosed as an aneurysm of the internal or of the common carotid artery. A man, aged 57, wounded himself with a knifelike instrument in the left side of the neck eight days before examination. The ensuing hemorrhage, which was free, was controlled by suture of the soft parts and a firm bandage. From the moment of the injury there was speech disturbance, but no other paralysis. Eight days after the accident, a swelling developed at the site of the wound. It was at this time that the patient was brought to the hospital. In the left side of the neck, corresponding to the course of the great vessels, was a fluctuating, expansile swelling the size of a hen's egg, with a systolic blow. The pulsation was influenced greatly by compression of the common carotid, but not completely arrested. Other than the statement that the author intended later to perform arteriorrhaphy no details are furnished concerning the case. The vessel at fault therefore remains in doubt.

Frisch [29] presented before the Royal Society of Physicians of Vienna, at the Dec. 10, 1915 meeting, a patient with what he believed an aneurysm of the internal carotid artery located in the neck close to the base of the skull. The trouble originated from a gunshot wound. The presence of such signs as hoarseness, atrophy of the sternocleidomastoid muscle, shrinkage of the half of the tongue corresponding to the injured side, the development of a contracted pupil and ptosis on the side of the injury indicated damage to the vagus, spinal accessory, hypoglossal and cervical sympathetic nerves. Behind the angle of the

27. Helman: Medycyna i. Kron. lek. **44**:708, 1909.

28. Rauchenbichler: Wien. klin. Wchnschr. **26**:84, 1913.

29. Frisch: Berl. klin. Wchnschr. **53**:99, 1916.

jaw was a pulsating swelling. Calcium lactate administered by mouth and pressure applied directly to the mass caused the pulsations to become less pronounced. While this is probably an aneurysm of the vessel under discussion, the evidence is not such as to warrant its inclusion in the tables.

Gasne [30] reports quite a similar case. A soldier was injured, March 12, 1916, by the concussion of a shell, as evidenced by the absence of a wound and failure to find, by roentgen-ray examinations, any foreign body embedded in the tissues. There was bleeding from the left ear, hemicrania, aphonia, embarrassed respiration and a tumefaction in the left carotid region. When admitted to the hospital, March 21, the entire left carotid and parotid regions were markedly tumefied. To touch, the involved area felt doughy rather than fluctuating, and exhibited neither expansion nor pulsation. Behind the angle of the jaw was a genuine tumor as large as an apricot, round, limited and animated by expansion and beats, and the seat of a souffle. Examination of the pharynx was difficult, owing to the pain produced by opening the mouth. The entire left wall of the pharynx was bulging. Gradually the swelling diminished, but the aneurysm preserved its characteristic features until April 6, when it began to fade away. By April 23, there were no more beats or souffle, and the swelling had almost entirely disappeared. The man was discharged, May 31, 1916. Six months later he was again at the front. Though ignorant of the patient's future course, Gasne regarded the swelling as an example of rupture of a large vessel from the shock of a bursting shell, which terminated in a spontaneous cure. He thought the vessel involved one of the carotids.

Knaggs [31] says that during the World War he had to deal with only four aneurysms of the neck. One of these arose from the neighborhood of the bifurcation, but unfortunately the writer does not mention which vessel was involved, and the description is such as to leave the reader in doubt. A soldier was wounded, Dec. 12, 1916. When he came under observation, December 27, there was a pulsating swelling, the size of a chestnut, behind the angle of the left jaw. It felt like a mass of inflammatory tissue. Jan. 26, 1917, a short, sharp systolic murmur appeared and the pulsation became expansile. The external carotid felt thicker at its most superficial part when compared with that on the other side, and the main swelling blended with this thickened part.

30. Gasne: Paris chirurg. **12**:212, 1920.

31. Knaggs, R. L.: Brit. J. Surg. **8**:167 (Oct.) 1920.

Jan. 27, 1917, the left common carotid artery was exposed and a temporary ligature applied at the level of the cricoid cartilage. A dissection of the sac was made, and its whole anterior surface and sides were exposed. It extended from the level of the bifurcation to the posterior belly of the digastric muscle. The parts were so matted as to render impossible the recognition of the anatomic structures involved or to complete the removal of the sac without danger of injury to important structures; consequently, the operation was concluded by tying the common carotid, without seeking the fragment of metal to which the lesion was attributed. May 14, the swelling had completely disappeared, its site being indicated by a little thickening. There was no bruit and the lesion appeared completely cured.

Goldamer [32] reports the case of a soldier who had a tear at the point where the right internal and external arteries diverge, the aneurysm being formed at the expense of both vessels. The wound in the external carotid was treated by lateral suture. The internal carotid was too badly damaged for restorative purposes and required a ligation. For many days after the operation the patient lay in a stupor with his eyes turned to the side of the injury and with spastic paralysis of the opposite side of the body. These serious symptoms developed despite a week's preliminary compression of the common carotid. The man finally regained complete health. It is mentioned that Reich [33] exhibited a man with simultaneous aneurysms of the internal and external carotid arteries due to gunshot wound at the Dec. 2, 1914 session of the Medizinische-Naturwissensshaftlicher Verein Tuebingen. However, no details are furnished. Herzen [34] saw an aneurysm involving both the internal and the external carotids simultaneously in a soldier wounded in the Russo-Japanese War, and in another soldier, one of the internal carotid artery. These cases are simply mentioned, no data being furnished.

The case is mentioned of a soldier who had had all three carotid arteries ligated for an aneurysm at the bifurcation. No other information is given except that the patient made a good recovery, without any impairment of power.

The cases of von Eiselsberg and Matthews, though not so stated, are apparently of the intracranial type. The case observed by von Eiselsberg

32. Goldamer: Beitr. z. klin. Chir. **106**:605, 1917.

33. Reich: München. med. Wchnschr. **62**:200, 1915.

34. Herzen: Chirourguia **30**:95, 1911; abstr. J. de chir. **7**:677, 1911.

was reported by Ranzi.[35] A soldier, aged 26, was admitted into the hospital, Feb. 17, 1917, for a wound received in the left cheek, fracture of the mandibular ramus, ankylosis of the jaw, exophthalmos, edema of the eyelid and a distinct roaring in the neighborhood of the parietal bone. Pinching of the exposed external carotid did not influence the noise, but with occlusion of the internal branch, the roaring was controlled. Therefore, April 12, the lumen of the left internal carotid was occluded to about three-fourths its normal caliber. October 26, one-half a year after the operation, the exophthalmos was reported as substantially improved and the noise greatly diminished. Matthews[36] records a case of somewhat the same character. A man was kicked by a horse on the left side of the head just above the zygoma, July 22, 1905. About a week afterward he developed a squint in the left eye. In September, 1905, he noticed impairment of vision. Somewhat later a buzzing sound appeared, with its point of greatest intensity located in the region of the zygoma. There was no external swelling, no pulsation, but a well marked bruit could be heard over the pterygoid region and the upper part of the posterior triangle. This could be stopped by compression of the common carotid artery. June 30, 1906, the common carotid artery was tied. The patient made an excellent recovery. Both the bruit and the buzzing entirely disappeared.

ARTERIOVENOUS TYPE

Aneurysms of the arteriovenous type number nineteen, of which eighteen were males and one a female. The ages of twelve only were recorded. The youngest was 20 and the eldest 48 years old. Nine were in their twenties; two, in their thirties, and one was in his forties. Seven were described as soldiers and two as men. All the cases resulted from trauma. Nine times the aneurysm was caused by bullets; four times by shrapnel; once by a stab wound; four times by war injuries; once from the concussion of a bursting shell, and twice by trauma. It is notably a disease of young male adults. Up to 1914, only four writers described this lesion; viz., Joret (1840), Giraldès (1854), Keen (1894) and Janssen (1903). Of the fifteen remaining patients thirteen were soldiers wounded in battle during the World War. Sixteen were operated on, with fifteen cures, or 93.75 per cent., and one failure, or 6.25 per cent. (Table 11). Three were treated expectantly, with 100 per cent. mortality; one died of cerebral softening and epilepsy thirty hours after the receipt of the injury; one succumbed from anthrax

35. Ranzi: Arch. f. klin. Chir. **110**:656, 1918.
36. Matthews: J. Roy. M. Corps, London **8**:1437, 1907.

TABLE 11.—*Arteriovenous Aneurysms Operated On*

Case	Author and Reference	Sex; Age; Side	Duration	Operation Date	Cured	Died; Cause	Remarks
1	Keen. Med. & Surg. Reporter, Philadelphia, **70**: 880, 1894	♂ 25 L	3 years	Ligation common carotid, external carotid and internal jugular vein, 8/15/1893	Yes	.....	Bullet wound; when first seen, Aug. 9, 1893, had contractures of right arm; aneurysmal bruit, thrill in left side of neck; slight external swelling; sought relief for persistent noise in ear, which prevented him from working; after operation, no mental disturbances; slight ptosis; pupils not affected, responded to light
2	Janssen: Ein Fall v. Aneur. shurium der Carotis interna u. Vena jugularis communis sinistra infolge Stichverletzung, Kiel, 1903, p. 11	♂ 21 L	4 adys	Ligation common carotid, external carotid, internal carotid, superior thyroid arteries and internal jugular vein, 8/22/1902	Yes	.....	Stab wound; first seen, Aug. 21, 1902, with pulsating swelling behind angle of left jaw; it was elastic and had thrill and souffle; condition considered dangerous; no untoward symptoms after ligation, save a persistent inequality of pupils
3	Haberer: Wien. klin. Wchnschr. **27**: 1477, 1914; also Arch. f. klin. Chir. **107**: 662, 1916	♂ 32 R	About 5 weeks	Quadruple ligation and extirpation of sac, 1914	Yes	.....	Soldier, wounded, Aug. 28, 1914; weakness in left extremities; dizziness; headache; behind angle of right jaw whirring swelling; paralysis of right sympathetic nerve; damage to right vagus nerve; after operation headache was relieved and paralysis gradually cleared up; Oct. 28, 1914, considered cured
4	Gilson-Hermann: J. belge de chir, **14**: 71, 1914, quoted by Lenormant, J. de chir. **17**: 138, 1921	♂ Soldier	.....	Ligation common, external and internal carotid arteries and internal jugular vein	Yes	.....	Bullet wound; 2 months later appearance of pulsation and thrill without tumor
5	Bland-Sutton: Brit. J. Surg. **3**: 490, 1915	♀ 27 L	7 weeks	Quadruple ligation, 12/5/1914	Yes	.....	Bullet wound, accidental; swelling; loud buzzing in left ear; thrill; murmur; operation followed by paralysis of right leg and arm; diplopia; hemorrhagic papillitis and double optic neuritis; complications attributed to thrombosis of cavernous sinus
6	Bier: Deutsch. med. Wchnschr. **41**: 122; 123, 1915	♂ Soldier	.....	Vessel suture, 1914	Yes	.....	Article contains no definite description of case; author states that during short space of 2 months, terminating Dec. 1, 1914, he had operated on 44 aneurysms in 43 patients; patient was disturbed both night and day by roaring in head; he mentions he had seen similar case in consultation
7	Lannois and Patel: Caducée **15**: 127, 1915; also, Patel: Lyon chir. **20**: 341, 1923	♂ 22 R	8 months	Ligation common carotid artery and internal jugular vein, obliteration of right lateral sinus by tamponade, 4/22/1915	No recurrence	....	Soldier, wounded by bullet, Aug. 26, 1914; symptoms: auditory disturbances; thrill; bruit; right lingual and laryngeal paralysis; immediate results were excellent, but on reexamination 7½ years afterward aneurysm had reformed; Patel withheld further operation for fear of result on cerebral circulation
8	Dufourmentel: Presse méd. **25**: 50, 1917	♂ 23 L	8 months	Ligation lateral sinus, 10/25/1915; ligation internal carotid artery, 11/10/1915	Yes, after second operation	.....	Soldier, bullet wound, Feb. 28, 1915; Oct. 5, 1915, while undergoing examination for deafness, purple, violently pulsating tumor noticed in floor of left external auditory canal; with first stroke of curet, profuse hemorrhage, controlled by tamponade; October 25, internal carotid artery exposed; as pressure on this vessel did not entirely control bleeding, under supposition that it came from internal jugular vein, rapid trephinement was made, left lateral sinus being laid bare and ligated; as bleeding repeated itself at each dressing, souffle persisted and pulsating tumor remained in floor of canal, internal carotid was again isolated and ligated, without the least immediate or remote cerebral disturbance
9	Ortenberg: München. med. Wchnschr. **64**: 237, 1917	♂ 24 L	.....	Ligation vertebral, internal and common carotid arteries, sac incised and packed with gauze, 11/1/1916	Yes	.....	Shell wound, with aneurysm of internal carotid artery, vertebral artery and lateral sinus; had had operation for cervical swelling believed to be an abscess; as free hemorrhage occurred, wound was closed and firm compression exerted; on entrance, powerfully pulsating swelling in left side of neck; first common and internal carotid arteries exposed and loose ligatures thrown around them; next, subclavian artery uncovered, vertebral located and tied; pulsation now weaker but not entirely stilled until internal carotid was ligated; believing circulation in sac controlled, it was laid wide open; immediate copious hemorrhage, arrested with the tightening of ligature around common carotid artery; clots removed and shell fragment extracted; occipital bone fractured and lateral sinus torn; tamponade of sac, wound partially closed; for a time loss of use of right leg, attributed to area of softening in left hemisphere

10	LeFort: Bull. Acad. de méd. 78 : 106, 1917	♂ Man L	3 months	Ligation internal jugular vein above and below fistula, sac incised, artery sutured, suture line reinforced by wall of vein	Yes	.....	Bullet wound; thrill in left side of neck; arrested by pressure; thumping in head; symptoms increasing in severity; with temporary ligatures removed, circulation through carotids was restored; after operation, no nervous phenomena
11	Soubeyran: Rev. gén. de clin. et de thérap. 31 : 876, 1917	♂ Soldier L	.....	Ligation common and external carotid arteries, incision of sac, tamponade, 5/12/1917	Yes	.....	Bullet wound; diffuse left parotidean swelling, activated by neither beats nor souffle; blood withdrawn on aspiration; first external carotid artery ligated and sac split, but as blood continued to trickle, common carotid was tied and sac packed; no facial paralysis
12	Suchanek: Arch. f. klin. Chir. 110 : 682, 1918	♂ Soldier R	About 6 months	Ligation and section of internal jugular vein near base of skull, narrowing internal carotid with muscle sling from sternocleidomastoid; 6 days later, ligation internal carotid artery proximally	Yes	.....	Gunshot wound; spastic paralysis left side of body; roaring in right ear; loud bruit over internal jugular vein, disappeared on compressing vein above; first operation under local anesthesia 25 weeks after injury, caused roaring in ear to disappear, but aneurysm reformed; pulsation became ever plainer, overlying soft structures thinner and thinner; rupture threatened and second operation was undertaken; paralysis improving when patient was discharged; in spite of existing hemiplegia, which induced employment of less radical method, no distressing symptoms were observed when circulation was totally cut off
13	Gault: XXXI Cong. franç. d'oto-rhinolaryng., quoted by Lenormant, J. de chir. 17 : 138, 1921	♂ Soldier	.....	Ligation internal jugular vein below the lesion, tamponading lateral sinus through a mastoid trephinement; ligation, next day, common carotid artery	Yes	.....	Shell wound; profuse secondary hemorrhage from pharynx; intrapharyngeal compression; then operation
14	Official History of the Great War, Medical Services, Surgery of the War, London, 2 : 243, 1922	♂ Soldier	.....	Ligation common carotid artery	Improved	.....	No cerebral disturbance followed but actual result on aneurysm was doubtful
15	Official History of the Great War, Medical Services, Surgery of the War, London, 2 : 237, 1922	♂ Soldier	6 weeks	Suture vent in vein, plication of sac	Improved	.....	Shrapnel wound; left sympathetic paralysis; 6 weeks later aneurysm was explored; sac was found interposed between internal jugular vein and lower end of internal carotid artery; when control ligatures had been tightened, sac was opened, but free hemorrhage necessitated clamping ascending pharyngeal and superior thyroid arteries; postoperatively some thickening at site of sac and hoarse, systolic bruit, but both were steadily improving
16	Rouvillois: Bull. Acad. de méd. 91 : 705, 1924	♂ 22 R	4 days	Ligation common, external and internal carotid arteries and internal jugular vein, with extirpation of sac, 9/5/1916	Yes	.....	Soldier, thrown violently to ground by concussion of bursting shell without leaving slightest trace of wound; vertigo; deafness; severe pain in right side of neck; on examination, tumefaction which beat in harmony with pulse behind angle of right jaw; thrill; souffle; slight nonpulsatile bulging right tonsillar region to sight, but to touch animated by beats; moderate exophthalmos, unassociated with pupillary or motor disturbances; slight dysphagia; slightly husky voice; paralysis of right vocal cord; no respiratory embarrassment, roentgenogram negative; postoperative course satisfactory; immediate and gratifying relief from humming in ear and annoying souffle, which had prevented all sleep; June 3, 1924, patient in good health

forty-four days after the accident, and one expired about three weeks after the receipt of the trauma (Table 12). A noteworthy feature of the operative series was the multiplicity of methods employed, with about equal success.

The methods were: ligation of the common carotid and the external carotid arteries and the internal jugular vein, one case; ligation of the common, external and internal carotid arteries and the internal jugular vein, two cases; ligation of the common carotid artery and internal jugular vein, with obliteration of the right lateral sinus by tamponade, one case; ligation of the common carotid, the internal carotid and the vertebral arteries, incision of the sac, gauze packing, one case; ligation of the common and external carotid arteries, splitting of the sac, packing, one case; ligation of the common carotid artery, one case; ligation of the common carotid artery and the internal jugular vein below the lesion, tamponading of the lateral sinus through an opening in the mastoid, one case; quadruple ligation, one case; quadruple ligation, extirpation of the sac, one case; ligation of internal carotid artery and lateral sinus, one case; ligation of common, external and internal carotid arteries and the internal jugular vein, with extirpation of the sac, one case; ligation and division of the internal jugular vein at the base of the skull, first narrowing of internal carotid artery by muscle sling, later proximal ligation, one case; suture of vent in vein, plication of sac over hole in the artery, one case; suture of vessel, no data given, one case; ligation ot the internal jugular vein above and below the lesion, arteriorrhaphy and capping with the sac wall, one case.

In view of the wide range of operations employed, the results are truly remarkable. The sole failure was the observation of Lannois and Patel [37] published as a success, following a tamponading of the right lateral sinus and ligation of the common carotid artery and the internal jugular vein. The immediate results were excellent. The objective and subjective phenomena disappeared promptly and the man was returned to active service. However, on reexamination 7½ years later, Patel [38] reports that the man had in the meanwhile developed a diffuse tumefaction of the right half of the face which resembled a large angioma, marked dilatation of the veins at the angle of the jaw and large pulsating venous lakes in the submaxillary region, with a systolic blow. The blood pressure, 25 systolic and 150 diastolic, indicated a leakage in the arterial system. Despite the application of three

37. Lannois and Patel: Caducée **15**:127, 1915.

38. Patel: Lyon chirurg. **20**:341, 1923.

ligatures, two venous and one arterial, to the common carotid artery just below its bifurcation, the external carotid artery had permitted the reestablishment of the intracranial circulation and at the same time pumped blood into all the branches of the internal jugular vein between the ligatures. Patel contented himself by remarking that ligation of the external carotid artery and the peripheral venous branches should lessen the vascular phenomena, but would not be without danger to the cerebral circulation. Leriche advised operation in spite of the technical difficulties on account of the rapidly developing cardiopathy in this type of case. Berard, in discussing the observation mentioned above, reported a case of arteriovenous aneurysm that he saw in 1916 at Paris; this case involved the internal jugular vein and the external and internal carotid arteries near their origin, and was at first treated by ligation of the common carotid artery and the internal jugular vein. The operation afforded some months of amelioration, when suddenly, following an effort, the signs of the arteriovenous aneurysm recurred. The condition was relieved by extirpation of the sac and ligation of all the contributory vessels.

In view of the fact that these aneurysms are liable to recur after a simple ligation of the vessels at fault, it would appear the better policy, whenever possible, to extirpate the sac by some such plan as practiced by Haberer and afterward by Rouvillois, unless a restorative operation is feasible; the latter course is preferable on account of the lessened chances of interference with the cerebral circulation. After restorative aneurysmorrhaphy, however, the possible formation of an arterial aneurysm must be considered. There are none in this group, but Reid [39] reports such a complication in an arteriovenous aneurysm of the right femoral vessels.

The question has arisen as to the most propitious time to operate, early or late. Lavenant [40] favors delayed operation in the belief that this plan jeopardizes life the least; but he says that an operation that restores the current in the artery is better still.

Almost invariably this lesion is caused by penetrating foreign bodies, such as bullets, pieces of shell and knives. The case of Rouvillois is a notable exception. After a most careful search of the literature I could find only one case of a like nature. This was reported by Gasne.[41]

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39. Reid, M. R.: Abnormal Arteriovenous Communications, Acquired and Congenital, Arch. Surg. **10**:601 (March) 1925, Case 10.

40. Lavenant: Paris chirurg. **11**:369, 1919.

41. Gasne: Paris chirurg. **12**:212, 1920.

TABLE 12.—*Arteriovenous Aneurysms Not Operated On*

Case	Author and Reference	Sex; Age; Side	Duration	Cured	Died; Cause	Remarks
17	Joret: Gaz. méd. de Paris **8**: 457, 1840	♂ 35 L	30 months	....	Yes; cerebral softening and epilepsy	Bullet wound, May 2, 1835; died, Oct. 23, 1837; four months after injury, epileptiform seizures and tumor size of pigeon's egg in left side of neck, with thrill and pulsation apparent to both patient and physician; necropsy: ball found encapsulated in internal jugular vein
18	Giraldès: Bull. Soc. de chir. de Paris **5**: 70, 1854	♂ Man L	1 month	....	Yes, in 44 days; anthrax	Bullet wound, June 15, 1854; swelling, thrill and murmur; necropsy: ball found in sac joining artery to vein
19	De Raffele: Riforma med. **36**: 345, 1920	♂ 20 R	About 3 weeks	....	Yes, Sept. 30, 1916; abscess of brain	Soldier, wounded, July 11, 1916; weakly pulsating swelling in parotidean region; on palpation, elastic, expansile throughout; thrill; systolic blow on auscultation; on compression of common carotid souffle became weaker; small, oval, soft tumefaction in right pharyngeal wall, which bulged into and slightly constricted alimentary tract; ptosis of right lid, weakness right facial muscles, interference with speech, annoying noises in right ear; dyspnea; dangerous cerebral symptoms when primitive carotid artery was compressed discouraged surgery; necropsy: aneurysm about 4 cm. above bifurcation

A soldier was injured, March 12, 1916, by the concussion of a shell, as evidenced by the absence of a wound and failure to find, by roentgen-ray examination, any foreign body embedded in the tissues. There was bleeding from the left ear, hemicrania, aphonia, embarrassed respiration and a tumefaction in the left carotid region. When the patient was admitted to the hospital, March 21, the entire left parotid and carotid regions were noticeably swollen. The involved area felt doughy rather than fluctuating, and exhibited neither expansion nor pulsation. Behind the angle of the jaw was a mass as large as an apricot, round, limited, animated by expansile beats, and the seat of a distinct souffle. Examination of the pharynx was difficult owing to the pain produced by opening the mouth. Gradually the swelling diminished. However, the aneurysm preserved its characteristic features until April 6, when it began to fade away. By April 23, there were no more beats or bruit and the swelling had almost entirely disappeared. The man was discharged, May 31, 1916. Six months later he was again at the front. Gasne regarded the swelling as an example of a rupture of a large vessel from the shock of a bursting shell which terminated in a spontaneous cure. He thought the vessel involved was one of the carotids.

Leconte and Oury [42] have described what they believe to be an analogous observation, but of the common carotid artery. The most remarkable feature of their case is the length of time that had elapsed between the receipt of the injury and the appearance of the vascular disease. In addition the case is another example of dilatation of the right ventricle, rather than of the left, following arteriovenous fistulas in the several regions of the body. A man, aged 31, was seen by Laubry, May 9, 1924, for dyspnea and distressing buzzing in the left side of the face. In 1917 he had received a bullet wound in the right cervical region. According to his statement, the wound was superficial and the projectile was easily extracted. Cicatrization occupied only a few days. It was further learned that the man at the time of the injury had suffered a severe concussion and had lost consciousness. From 1917 to 1922 he had led an absolutely normal life. In 1922, after any effort he began to experience some shortness of breath. For two years this was practically the only symptom. It was at first transitory, but finally led him to discontinue all work. More recently he had had attacks of vertigo, and on one occasion a syncope of short duration. Some weeks before this time another symptom appeared, an annoying sensation in the left cervical region, associated with an intermittent buzzing in the left ear and

42. Leconte and Oury: Bull. et mém. Soc. méd. d. hôp. de Paris **48**:906, 1924.

rhythmic pulsations in the head. Examination of the precordial and the left cervical regions left no doubt as to the cause of the trouble. In close proximity to the left sternoclavicular articulation, the examiner felt an intense thrill, heard a loud murmur of systolic intensification, and perceived a decidedly abnormal bulging in the course of the cervical vessels, with arterial expansion. Fluoroscopy disclosed a decided bulging in both the right chambers of the heart. An electrocardiogram, however, did not show anything abnormal in the tracings. A Wassermann test was negative, as was the remainder of the examination. Although the only hope for relief held out to the patient was operation, he refused to avail himself of the chance thus offered. A somewhat similar case has been reported by Ruttin.[43] A soldier was admitted to the hospital, Jan. 17, 1918, for bleeding from the left ear, the nose and the mouth. In November, 1917, while serving on the Italian front, he was buried by the explosion of a shell. Since 1914 he had had a discharging left ear, which was rendered worse by the accident. On entrance the left ear was discharging a quantity of foul pus and the patient complained of severe pain in the head. After admission the hemorrhage from the nose, the mouth and the ear renewed itself on several occasions; therefore, on Jan. 18, 1918, a radical mastoid operation was undertaken. January 20, there was renewed bleeding from the mouth and the nose, and the man died. Necropsy showed the presence of an aneurysm of the internal carotid artery in the knee of the carotid canal, the wall of which was eroded. As will be noticed, the cases of Heuer and Cushing have not been included in the present tables. Though my authority, Callander,[44] did not specifically say that they were extracranial, I interpreted them in my earlier paper as such, but wrongfully as these cases are classed as intracranial in an article by Reid.[45] A revision is therefore necessary, and they must be dropped as examples of the lesion under discussion.

In conclusion I cannot impress on the profession too forcibly that aneurysm of the internal carotid artery in its cervical portion is not the rare lesion that it once was thought to be; that it is not a benign lesion, as the many catastrophes related in this study bear witness; that operative attack offers a fair percentage of cures, while pacific management or internal therapeusis is almost invariably followed by death. While spontaneous cure may occur, it is unusual, only one instance in this series

43. Ruttin: Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres **11**:224, 1919.
44. Callander: Johns Hopkins Hos. Rep. **19**:301-302, 1921.
45. Reid (Footnote 39, Cases 5 and 11).

being so recorded. A sufficient number of observations have been placed on record to serve as a warning to physicians that a unilateral lump in the throat may be an aneurysm and should be so regarded until proved otherwise, if unfortunate disasters are to be avoided. It is far better to be careful than to be sorry afterward and to repent at leisure a hasty act.[46]

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46. Since this article was written the following example of spontaneous aneurysm in the extracranial portion of the internal carotid artery has been published by Reid (Aneurysms in the Johns Hopkins Hospital, Arch. Surg. **12**:1-74 [Jan.] 1924, Case 55). The patient, a white woman, aged 61, married, was admitted to the hospital, Aug. 27, 1919, for an extracranial aneurysm of the right internal carotid artery of one year's duration. She gave no history of syphilis and the Wassermann reaction was negative. The trouble began with a tickling sensation in the throat. Later, a swelling resembling a peritonsillar abscess protruded into the right side of the pharynx. Eight weeks before admission an incision had been made into this swelling. The mass was pulsatile and involved the soft palate and tonsil. It did not show externally. September 2, Reid ligated the right internal carotid artery. Occlusion of the external carotid artery had no effect on the aneurysm. The pulsation (much reduced by the operation) promptly returned and lasted for eight days. During this time there was an intense right sided headache. Then the aneurysm clotted, pulsation stopped and the headache had become much less before her discharge. At no time were there any signs of paralysis. May 29, 1922, the patient wrote that she still felt a little fulness in the throat, which, however, did not pulsate.

THE FUNDAMENTAL PRINCIPLES OF THE TREATMENT OF GASTRIC AND DUODENAL ULCERS*

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The final decision as to the choice of a surgical procedure for the cure of gastric and duodenal ulcers must rest at present on the empirical observations of our statistical studies. That operation is best which gives the best results in the largest number of cases and which can be performed with a low mortality. Such a purely empirical attitude is forced on us by our lack of knowledge both of the normal and the pathologic physiology of the stomach and of the etiology of the lesion we attempt to treat. But at the same time this method, though necessary at present, is not the ideal scientific attitude, which seeks rather to base its procedures on demonstrable truths. The numerous studies, on man and the lower animals, striving steadily to establish those facts which will permit us rationally to conceive and carry out our surgical procedures are slowly beginning to bear fruit. The first step of a scientific inquiry is the accumulation of facts. The second is the attempt to establish some principles that will explain these facts. Perhaps we are already justified in attempting the latter. This article will discuss some of these fundamental principles that have already been accepted by many and at the same time point out what they permit us to explain and what they portend for the future surgical therapeusis of gastric and duodenal ulcers.

PREDISPOSITION TO ULCER

There is an individual predisposition to gastric and duodenal ulcers. There has long been a feeling among physicians and surgeons that most patients with gastric and duodenal ulcers belong to a definite group. This belief is the result of observations of numerous points of similarity among these patients and of the marked tendency in them of the ulcer to recur. The question is, of course, part of the much larger problem of congenital diathesis and acquired predisposition to disease. The pursuit of such an inquiry is manifestly beset with many difficulties. In the first place, a workable and inclusive classification is necessary to permit the charting of the similarities and differences among men.

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Draper [1] has suggested the following classification. He calls his divisions the "panels of personality," and labels them under the separate headings (1) anatomy, (2) physiology, (3) psychology and (4) immunity. If we accept this classification, we may say that the work that has been done along these lines to ascertain the characteristics of the "ulcer group" may, with the exception of Draper's anatomic studies, be included under the heading physiology. The physiologic observations follow.

Von Bergman's [2] Views.—In chronic lead poisoning the structures of the nervous system are markedly affected. The destructive lesions, however, are found not only in the peripheral nervous system and brain but also in the vegetative nervous system. Thus degeneration of the vagus may occur. Further, a large number of patients suffering from this malady present symptoms markedly resembling those of peptic ulcer. And in the statistics that he quotes one third of these were definitely proved to be due to ulcer. We have, then, an appreciable number of patients developing a gastric ulcer following (1) a destructive lesion of the autonomic nervous system, and (2) a tendency to colic, that is, muscular spasm.

Von Bergman then argues by analogy that other causes may bring about a disharmony between the vagus and the splanchnic systems, and similarly produce localized or generalized spasms in the muscles of the stomach or duodenum, or in the terminal blood vessels. Persons suffering from ulcer often possess a large number of disturbances in the autonomic nervous system, but we cannot accurately classify them, for the symptom complexes of disorders within this system have not as yet been precisely defined. The further elaboration of his theory into the actual causation of the ulcer by digestion of the ischemic area need not be considered here. What concerns us now is his contention that in a large number of patients with ulcer definite variations from the normal are found in the autonomic nervous system. These variations have further been carefully studied by Westphall.[3] To the argument that many patients with these changes do not develop ulcer, von Bergman counters that the ulcer is merely a local manifestation of a systemic condition. In the same way not every patient suffering from syphilis develops tabes. The latter condition is merely an occasional local manifestation.

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1. Draper, G.: Diagnosis and Treatment, Endocrinology **3**:164 (April-June) 1919.

2. Von Bergman, G.: Zur Pathogenese des chronischen Ulcus pepticum, Berl. klin. Wchnschr. **55**:524, 1918.

3. Westphall, K.: Untersuchungen zur Frage der nervösen Entstehung peptische Ulcera, Deutsches Arch. f. klin. Med. **114**:327, 1914.

Hurst's[4] *Views.*—The examinations of normal students[5] show that in some there is a persistent hypertonic stomach associated with hyperchlorhydria. These, he says, have "an inborn variation from the average normal, which manifests itself in hypertonus of the stomach with active peristalsis, rapid evacuation, and hyperchlorhydria with hypersecretion." This is caused "no doubt by an unusual degree of tonic activity of the vagus nucleus; it is strictly localized to that part which controls the activities of the stomach, and is not accompanied by a slow pulse or other signs of general vagotonia." This diathesis may be retained throughout life without the development of a pathologic lesion. But because of the greater peristaltic activity of these stomachs there is swept over into the duodenal cap larger quantities of a more concentrated acid, especially during the intervals between meals when the normal stomach usually is at rest. The actual cause of the ulcer he believes to be a bacterial infection, but the more or less constant presence of acid in the duodenal bulb is a contributing cause for its persistence. He has not encountered a case of duodenal ulcer except in a patient with this type of stomach, and he believes further that this "hypersthenic gastric diathesis" persists after the ulcer heals spontaneously, or even after gastro-enterostomy. Hurst, like von Bergman, emphasizes a basic change in the autonomic nervous system, but interprets its effects in a different way.

Koennecke,[6] while studying the effects of the pylorus on the genesis of ulcer, performed some experiments that bear on this problem. He sidetracked the antrum and pylorus and established a direct continuity between the body of the stomach and the duodenum. This was without appreciable effect. If in addition to these procedures the splanchnic nerves were divided in the abdomen, and the branches of the celiac ganglions also were severed then in a large percentage of cases ulcers developed. Here we have the experimental production of what might be termed an abdominal vagotonia, or at any rate a disturbance in the normal workings of the autonomic nervous system. It seems possible that this may have produced the disposition to ulcer, and that other factors, later to be discussed, were directly responsible.

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4. Hurst, A. F.: The Hypersthenic Gastric Diathesis, Lancet **2**:1369 (Dec. 30) 1922; Pathogenesis of Gastric and Duodenal Ulcer, Guy's Hosp. Rep. **74**:413 (Oct.) 1924.

5. Baird, M. M.; Campbell, J. M. H., and Hern, J. R. B.: The Importance of Estimating Chlorides in the Fractional Test Meal Samples, and Some Experiments with the Duodenal Tube, Guy's Hosp. Rep. **74**:23 (Jan.) 1924. Campbell, J. M. H., and Conybeare, J. J.: Comparison of the Test Meal and X-Ray Examination of the Stomach in Health, Guy's Hosp. Rep. **74**:354 (July) 1924.

6. Koennecke, W.: Experimentelle Untersuchungen über die Bedeutung des Pylorusmagens fur die Ulcusgenese, Arch. f. klin. Chir. **120**:537, 1922.

In their anthropometric studies, Dunn and Seegal[7] found that patients with peptic ulcer presented definite anatomic variations when compared with those suffering from gallstones. These differences were remarkably constant.

Mention was made above of Draper's classification of men for the investigation of individual variations; namely, (1) anatomy, (2) physiology, (3) psychology and (4) immunity. It does not seem likely (although we cannot say with certainty) that any studies to prove individual predisposition to ulcer could be performed under the third heading, that is, psychology. But if, as Rosenau maintains, a streptococcus that possesses an elective affinity for the stomach and first part of the duodenum is the immediate cause of ulcer, it would appear that fruitful results might be achieved by investigations under the fourth heading, that is, immunity.

Concerning the first postulate, that there is an individual predisposition to ulcer, we may say in conclusion that it is not as yet proved; that, however, even the foregoing brief survey shows adequate grounds for its acceptance as a working hypothesis, and that it yields the possibility of numerous further suppositions whose investigation should be of distinct value.

THE RELATION OF HYDROCHLORIC ACID TO ULCER

Hydrochloric acid is an essential factor in the production of ulcer. A little reflection on the pathogenesis of gastric and duodenal ulcers soon forces on us the conviction that hydrochloric acid is in some way intimately bound up with their production. These ulcers occur where acid occurs. Under normal conditions this means in the stomach and beginning of the duodenum. But when a new passage is created between the stomach and some other portion of the intestinal tract and acid reaches these strange parts, then ulcers may promptly appear. Gastrojejunal or jejunal ulcers are only too well known. And recently Berg[8] found a large indurated gastro-ileal ulcer in a patient where a surgeon had by mistake performed a gastro-ileostomy.

Of course, the argument that some ulcers are found when the test meals shows an anacidity immediately comes to mind. This objection will be fully answered presently.

Before we consider in detail the relation of acid to ulcer it will be necessary to consider the changes that have taken place in our conception of the regulation of gastric acidity. An understanding of this mechanism is also essential for an evaluation of the various surgical procedures.

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7. Draper, G. D.; Dunn, H. L., and Seegal, D.: Studies in Human Constitution: 1, Clinical Anthropometry, J. A. M. A. **82**:431 (Feb. 9) 1924.

8. Berg, A. A.: Personal communication to the author.

Mechanism of the Pylorus.[9]—Material of fluid or pulpy consistency is forced into the antrum by the tonus of the fundus and body and by the peristaltic waves of the latter. Every advancing peristaltic wave in the antrum normally forces a portion of this chyme into the duodenum. The remainder slips backward through the circular opening of the advancing wave. During the early part of digestion if a solid piece of food finds its way into the antrum, it is carried back to the body by retrograde peristalsis. During the latter part of digestion the consistency of the expressed material seems to be thicker. In other words, it is the *fluidity* of the gastric contents that is of prime importance. The acidity on the gastric or duodenal side of the pylorus does not control the opening and closure of that sphincter during digestion.

Following the entrance of food into the stomach the pylorus attains a certain degree of tone. This tone may result in its closure, but it yields readily to an increase of pressure in the antrum produced by contractions of the latter. Normally, during the greater part of the progress of the peristaltic wave through the antrum, the pressure is sufficiently high to force fluid chyme in a steady stream through the diaphragm-like opening of the pylorus, regardless of the reaction of this chyme. When the peristaltic wave reaches the pylorus it then effects a firm closure of this sphincter and prevents regurgitation of the material that has just been forced through. When four waves per minute are coursing over the stomach the length of time during which the pylorus is open and chyme is being forced through averages about ten or eleven seconds. The length of time which the sphincter is closed after the wave has reached it averages from about four to five seconds. In other words the pylorus is open for a greater length of time than it is closed. I am speaking now, of course, of the period of digestion, and when peristaltic waves are passing down the stomach. Furthermore, retrograde peristalsis in the duodenum may force back intestinal fluids through the pylorus at any time that the pressure there is higher than that in the antrum.

The important things to remember are that during digestion (1) the pylorus is open more of the time than it is closed, and (2) mere pressure relations govern the to-and-fro passage of fluids through this sphincter.

Regulation of Gastric Acidity.—Pure gastric juice as it is secreted by the stomach contains from 0.35 to 0.5 per cent hydrochloric acid. The researches of Pawlow [10] established this and innumerable observations by

9. For a complete consideration of the experiments leading to the following conclusions the reader is referred to Klein, E.: Gastric Motility: III. The Mechanism of the Pylorus, Arch. Surg. **12**:1224 (July) 1926.

10. Pawlow, I. P.: The Work of the Digestive Glands, translated by W. H. Thompson, London, 1910.

others have since confirmed it. This corresponds to a free hydrochloric acid of from 95 to 135. On the other hand, the acidity of the gastric contents at the height of digestion usually does not go higher than 0.2 per cent. What accounts for the difference? At first thought one would attribute it to the dilution accomplished by the food. However, the intestinal tract cannot only reduce the strength of its own acidity, but if 0.5 per cent hydrochloric acid is introduced by mouth or through a gastric fistula, there is a progressive reduction effected in the concentration, and the motility is markedly delayed until this occurs. Boldyreff [11] first showed that this reduction is accomplished by a regurgitation of the alkaline pancreatic juice. By successively excluding all possible factors, such as the bile, the intestinal juice, the saliva and an alkaline secretion from the stomach, he found that none of these could bring about an appreciable reduction. Only the pancreatic juice was very potent, and if it was excluded the concentration of acidity remained almost unchanged.

Boldyreff's conclusions are being more widely accepted every day.[12] Among some of those who agree may be mentioned Hicks and Visher, Spencer, Neyer, Rehfuss and Hawk, Deutsch and Rürup, Morse, Gross [13] and others.

Bolton and Goodhart [14] have recently also added evidence from test meal observations. In the tabulation of the results of the Rehfuss test meal there is in the majority of normal cases a rather rapid rise of the concentration of hydrochloric acid till the maximum is reached in about one and one-half hours. From this peak there is a sharp decline. They found by chloride determinations that this sudden diminution in the concentration of hydrochloric acid was not due to dilution, but to a neutralization. And further observation convinced them that the alkali of the pancreatic juice was responsible.

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11. Boldyreff: The Self Regulation of the Acidity of the Gastric Contents and the Real Acidity of the Gastric Juice, Quart. J. Exper. Physiol. **8**:1, 1914.

12. For a complete discussion the reader is referred to Klein (Footnote 9).

13. Hicks and Visher: The Mechanism of the Regurgitation of Duodenal Contents into the Stomach, Am. J. Physiol. **39**:1, 1915. Spencer, W. H.; Meyer, G. P.; Rehfuss, M. E., and Hawk, P. B.: Direct Evidence of Duodenal Regurgitation and Its Influence upon the Chemistry and Function of the Normal Human Stomach, Am. J. Physiol. **39**:459 (Feb.) 1916. Deutsch, G., and Rürup, H.: Ueber den Rückfluss von Pankreassaft in den Magen und die Bestimmung der Salzsäurerestenz des Trypsins, Deutsches Arch. f. klin. Med. **138**:165 (Jan.) 1922. Morse, W. E.: The Relation of Acid to Gastric Discharge and Duodenal Regurgitation in the Dog, Am. J. Physiol. **41**:439 (Oct.) 1916. Gross, O.: Ueber der physiologischer Rückfluss von Pankreassaft in den Magen, Deutsches Arch. f. klin. Med. **132**:121 (April) 1920.

14. Bolton, C., and Goodhart, G. W.: Duodenal Regurgitation into the Stomach During Gastric Digestion, Lancet **1**:420 (March 4) 1922.

We have then a nice mechanism that, when the acid concentration in the stomach reaches a certain level, normally accomplishes its reduction. The regurgitation probably follows on the stimulation of the duodenal mucosa by irritant concentrations of acid.[15]

As a result of these observations we must now divide all cases of anacidity into two groups. In the first no acid is secreted and an examination of the total chlorides in the gastric test meal will show that they are low. In the second group, there may be no free acid but the total chlorides are high. As these chlorides come almost entirely from hydrochloric acid, this means that the acid *was* secreted but was subsequently neutralized. Thus Bennett and Ryle [16] had come to the conclusion from examination of normal medical students that about 4 per cent of people have achlorhydria. Baird, Campbell and Hearn later performed similar test meals, again on medical students, and at the same time made chloride determinations. They encountered four cases of anacidity. Three of these were shown to be due to neutralization of hydrochloric acid that had been secreted. The fourth was a true achlorhydria and was in an individual who was not healthy.

Hyperchlorhydria is due to faulty neutralization. Granted that intestinal regurgitation is the mechanism for the reduction of acidity, then every case of hyperchlorhydria is in the last analysis due to faulty neutralization. It is, of course, remembered that acid is secreted at a concentration of from 0.35 to 0.5 per cent, or in the language of the test meal from 95 to 135 free hydrochloric acid. This faulty neutralization may be due to either (1) chemical or (2) mechanical factors.

(1) It is conceivable that if there is too much acid, as in hypersecretion, the normal amount of alkali will be insufficient to neutralize it. On the other hand there may under exceptional conditions be an insufficient quantity of alkali available.[5] I do not believe either of these factors to be often responsible for marked variations from the normal in gastric acidity.

(2) I believe that the mechanical or pressure relations more often are at fault. Too great pressure on the gastric side may prevent adequate regurgitation of the pancreatic juice. This may occur, for instance, in the hypertonic stomach, so strongly emphasized by Hurst,[4] or with hyperstalsis. But the fault may also lie on the duodenal side. I do not know of anyone who has mentioned this, but it may be of great importance, especially in pathologic states. We do not know definitely the manner in which the duodenum forces back contents into the stomach.

15. Klein (footnote 9).

16. Bennett, T. I., and Ryle, J. A.: A Study of Normal Gastric Function Based on the Investigation of One Hundred Healthy Men by Means of the Fractional Method of Gastric Analysis, Guy's Hosp. Rep. **71**:286 (July) 1921.

Presumably it is by retrograde peristalsis, for that type of muscular activity is known to occur there. It is reasonable to suppose that the nervous mechanism which is responsible for this peristalsis may be deranged because of a pathologic lesion, such as an ulcer, or that the actual destruction of muscular tissue and the adhesions resulting from an ulcer may directly interfere with the peristaltic waves and the creation of sufficient pressure to force the duodenal contents back into the stomach. That marked deformities of the duodenum often result is well known. This is again recently emphasized by Robertson and Hargis.[17]

The pylorospasm or organic obstruction that often accompanies ulcer is a further hindrance to proper neutralization. Very high acidities are usually encountered in cases of pyloric stenosis. I believe that these mechanical interferences with the normal pressure relations are by far the most common cause of hyperchlorhydria.

Experimental Influence of Acid on Ulcers.—We may now briefly review some of the experimental work relating to the influence of acid on ulcer. This work has been in part along two lines, first, the addition of large quantities of acid to the gastric contents, and, second, the elimination of the normal alkaline juices, thus indirectly increasing the acidity. One should nevertheless not lose sight of the probability that it is not necessarily increased acidity as is so often demanded but rather merely acidity which is necessary for the pathogenesis of ulcer in the predisposed human being.

In one type of experiment [18] the duodenum was extirpated and the pancreatic juice was either deflected to the surface or to a lower portion of the gastro-intestinal tract. The result was that a highly acid gastric juice entered the jejunum and ulcers were frequently found to follow. If the acid was again neutralized the ulcer healed rapidly.[19]

In a second type of experiment, the feeding of large quantities of acid after a gastro-enterostomy had been performed [20] led to no pathologic lesion. Apparently the alkali of the intestine could neutralize the excess. But if an entero-enterostomy was added to the foregoing procedure then a gastrojejunal ulcer often resulted. It is probable that the anastomosis between the loops of the jejunum deflected the alkali from the gastro-enterostomy stoma.

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17. Robertson, H. E., and Hargis, E. H.: Duodenal Ulcer: An Anatomical Study, M. Clin. N. Amer. **8**:1065 (Jan.) 1925.

18. Bickel, A.: Beobachtungen an Hunden mit exstirpierten Duodenum, Berl. klin. Wchnschr. **46**:1201, 1909. Mann, F. C., and Williamson, C. S.: The Experimental Production of Peptic Ulcer, Ann. Surg. **77**:409 (April) 1923. Mann, F. C.: Production and Healing of Peptic Ulcer, Minnesota Med. **8**:615, 1925.

19. Mann (Footnote 18, third reference).

20. Exalto: Ulcus Jejuni nach Gastroenterostomie, Mitt. a. d. Grenzgeb. d. Med. u. Chir. **23**:13, 1911.

The feeding of acid was also studied in a different manner. After the production of an experimental ulcer by a vast variety of means it has been found that spontaneous healing rapidly follows. After producing such a lesion in monkeys, Bolton [21] added hydrochloric acid to their food. As a result healing was delayed to two or three times the normal period. If in addition the pylorus was partially obstructed the delay was still more marked. He also found that foods which caused a relatively longer presence of hydrochloric acid in the stomach caused a proportional delay in healing. Thus on a milk diet ulcers were found to have healed on the twentieth day, whereas on a meat diet after the same length of time there was still a large epithelial defect. Some other experiments of Bolton should be mentioned. He prepared a toxin from the gastric wall which on intravenous injection was followed by an acute gastric ulcer, but only when acid was present in the stomach. If all the acid was neutralized by the oral administration of alkali, then no ulcer followed.

It may perhaps be asked why pepsin rather than hydrochloric acid has not been held accountable. But pepsin, of course, even if its proteolytic action is an important factor, can only act in the presence of acid, and therefore the acid remains a sine qua non.

As matters stand now, I believe it fair to say that clinical and pathologic observations of gastric and duodenal ulcers in man justify the working hypothesis that acid is a necessary element in their production, and that the experiments in animals lend support to that view.

ACID CONDITIONS IN GASTRIC AND DUODENAL ULCERS

Acidity Accompanying Gastric Ulcer.—Test meals, both Ewald and Rehfuss, show that in gastric ulcer there is usually a normal acidity. Some cases have a diminished acidity and some an anacidity. In Bell's [22] series of observations the percentages happen to be 72 per cent normal, 11 per cent hypo-acidity and 14 per cent anacidity. The patients with the normal percentage do not interest us at present. In them the mechanism for the neutralization of acid proceeds without hindrance. But several questions may be asked concerning those with a diminished or absent finding of acid. In the first place, is this not contrary to our postulate that hydrochloric acid is a contributing cause for the ulcer? We have just seen that an anacidity in the test meal does not necessarily mean that hydrochloric acid is not being secreted. An examination of the chlorides will often show that the anacidity is due to neutralization. I do not know if anyone has investigated the cases

21. Bolton, C.: Ulcer of the Stomach, London, 1913.

22. Bell, J. R.: Gastric Ulcer and Achlorhydria, Arch. Int. Med. **32**:663 (Nov.) 1923.

of anacid gastric ulcer from this standpoint, but Apperly [23] studied some cases of anacidity following gastro-enterostomy and found that in these it was due to neutralization. I have little doubt that the same holds true in the cases of gastric ulcer.[24] Presumably at the time of the formation of the ulcer free acid is present. It has been shown that many gastric ulcers produce or are accompanied by a diminution in tone of the antrum and a weakened gastric peristalsis. In fact there may be such marked atony occasionally that barium residues persist after forty-eight or seventy-two hours.[25] This hypotonia and weakening of peristalsis has been experimentally produced by lesions of the lesser curvature.[26] These conditions of diminished pressure on the gastric side distinctly favor intestinal regurgitation, and are sufficient to account for an apparent hypo-acidity, or anacidity. The view of Hurst [4] that the gastritis that accompanies the ulcer is responsible for a diminished secretion of hydrochloric acid may also be mentioned. We may say then that no one has yet shown that an ulcer may arise in an anacid medium, that all the evidence points to the contrary. When anacidity is present in the test meal, it is probably due to neutralization of secreted acid.

Acidity Accompanying Duodenal Ulcer.—In cases of duodenal ulcer anacidity is exceedingly rare. Hurst [4] has never observed a case. Nor have I been able to find one in our records. Normal acidity is found in a percentage somewhere around 65, and a hyperacidity in about 35. Of course the actual figures are not so important as a search for the principles involved. We may say again that in the normal cases there is no disturbance in the mechanism for the regulation of the acidity, or at any rate it is insufficient to prevent the acidity from attaining its usual level. The hyperacidity in some of the cases is readily explained. There may be, first, increased pressure on the gastric side tending to hinder regurgitation. Thus a characteristic finding in cases of duodenal ulcer is hypertonicity and hyperstalsis in the stomach. That has previously been mentioned. Second, there may be a lowering of the necessary pressure on the duodenal side. Reference has already been made to this. While there are as yet no experimental observations to substantiate

23. Apperly, F. L.: The Mechanism of Hyperchlorhydria, M. J. Australia **1**:33 (Jan. 13) 1923; Achlorhydria: An Investigation into Its Nature with Suggestions for Its Treatment, ibid. **2**:135 (Aug. 11) 1923; Gastro-enterostomy: Observations on Its Mechanism and on the Production of Pain in Duodenal Ulcer, ibid. **1**:256 (March 15) 1924.

24. Experiments to test this point are now in progress.

25. Schlesinger, E.: Chronische Gastroparese als Ursache scwerster motorischer Insuffizienz bei freiem Pylorus, Mitt. a. d. Grenzgeb. d. Med. u. Chir. **32**:30, 1920.

26. Klein, E.: Gastric Motility: II, The Conduction of the Gastric Peristaltic Wave, Arch. Surg. **12**:583 (Feb.) 1926.

this conclusion, it does not seem to me unreasonable to believe that when a severe lesion like an ulcer is present in the duodenum, it will hinder the normal mechanism of regurgitation, whether that mechanism be a general increase of tone, or a retrograde peristaltic wave. Third, a heightened degree of pyloric tone (or pylorospasm) aids both the foregoing factors. Of course it is not necessary that all three of these conditions be present in order to produce a hyperacidity. Also they may vary in degree in different persons and from time to time in the same person.

Acidity Accompanying Pyloric Ulcer.—Ulcers at or near the pylorus are often classified as a third group. They are frequently associated with a hyperchlorhydria, especially when a marked organic obstruction exists. From what has been said above, the reason for the increase of acidity in these cases is obvious and needs no detailed explanation.

PROBLEM OF HEALING

The reparative powers of the organism cannot heal all peptic ulcers. Our views as to whether chronic peptic ulcers may be cured without operation may be quite divergent. On two points, however, I believe all will agree. In the postmortem room healed ulcers are occasionally found in which the scar tissue involves the submucosa and muscularis as has been noted by Stewart [27] and Hart,[28] among others. Evidently this is a healed chronic ulcer. To call it something else is merely rationalizing. This implies that the defensive powers of the organism may, under certain conditions, effect a cure entirely unaided. On the other hand, even the most enthusiastic proponent of medical cures must confess that he cannot cure all ulcers. In these cases the powers of the organism aided by all the skill of the physician are not sufficient to heal the ulcer. That is the significance of the third postulate. But one thing that is often overlooked is that the operative procedure which is most commonly used, namely gastro-enterostomy, depends on the organism itself for the actual cure of the ulcer, and so acts in principle just as the medical treatment does. From the surgical point of view we may term as indirect all those methods, whether they be medical or surgical, which do not deal with the ulcer directly, and which aim so to alter conditions that the natural powers of cure will come into the ascendancy.

I do not propose at present to consider the exciting cause of the ulcer. To do so would in the present state of our knowledge mean the enumeration of many theories. For purposes of discussion let us call this exciting cause x. In view of what has gone before we may

27. Stewart, M. J.: The Healing of Gastric Ulcer, Brit. M. J. **2**:1164 (Dec. 16) 1922; The Pathology of Gastric Ulcer, ibid. **2**:955 (Nov. 24); 1021 (Dec. 1) 1923.

28. Hart, C.: Ehrebungen und Betrachtungen über das Geschwür des Zwölffingerdarmes, Mitt. a. d. Grenzgeb. d. Med. u. Chir. **31**:291, 1919.

now say that peptic ulcer arises in a predisposed person when acid is present in the stomach and when the exciting cause, which we have called *x*, occasions it. No doubt, some would prefer to replace the acid factor by the broader term "local predisposing causes," so that it could include traumatic and other agents and the short straight vessels on the lesser curvature. I have no objections, provided we remember always that the acid is an essential element.

Against these factors producing ulcer are arrayed the opposing forces of the organism. It is necessary to divide these into two parts, the defensive powers and the reparative powers. Thus it is not always true that when the exciting cause of a lesion is overcome or ceases to act healing will follow. A common example is one of the roentgen-ray lesions. Here the rays cause the initial trauma, which produces an ulcer, but at the same time they may so change the surrounding cells that healing is permanently inhibited. We must, therefore, in our present state of knowledge concede the possibility that even when all the factors which lead to the formation of an ulcer are removed, in some cases healing may, nevertheless, not take place because of permanent changes in the neighboring cells.

Arranging the foregoing statements symbolically, we have,—ulcer results when:

x + hydrochloric acid + individual predisposition > defensive powers + reparative powers.

In what we have termed the indirect method of cure, our efforts must be (1) to strengthen the resisting forces or (2) to weaken or abolish one or more of the "ulcer forces." Little work has been done under the first heading although the attempts to treat ulcer by protein therapy and by vaccines may be classified here. If the ulcer is due to bacteria, attempts to increase the resistance would appear to be a fertile field for study, and perhaps furnish the ultimate method of cure for ulcer.

Most methods of treatment fall into the second group, the attempt to weaken the "ulcer forces." Nearly all the medical procedures attempt to diminish or abolish the second of our three factors, the hydrochloric acid. And in the opinion of a host of surgeons the most common surgical procedure, namely gastro-enterostomy, owes whatever efficiency it has to the same reason. Its ability, however, to produce decided and permanent changes in acidity seems very variable.

We must remember, however, that we are dealing not with two factors, but with at least five, and possibly more; further, that these no doubt vary quantitatively from time to time. What has been termed

the "life cycle" of ulcer,[29] the periods of healing and breaking down, is probably due to such variations. We cannot, therefore, expect that the removal of one predisposing factor, such as acid, even though the quantitative relations are changed, will *always* result in a cure. And so we see that the most assiduous trial of the indirect methods may result in failure, and all empirical observations of patients entirely agree with these theoretical considerations.

By the indirect methods, then, we cannot at present hope to cure all our patients. This is true because of the considerations just stated and for a second important reason. From the standpoint of the patient, the healing of the pathologic lesion does not necessarily effect in him a cure. Thus, we may conquer an infection in a tendon sheath, but if the patient is left with a stiff finger we can hardly call our effort a cure. In addition to healing the local lesion, we must leave the patient with a gastro-intestinal tract that will function as nearly perfectly as possible.

For the present the ideal method toward which we must strive must, therefore, be a direct method. It should aim to get rid of the ulcer in 100 per cent of the cases. If the ulcer is removed that at once solves the problem of healing. It does not call on the factors of defense, which according to our postulate cannot heal all ulcers. From the surgical standpoint this means excision. In order to prevent a new ulcer our method must then remove as nearly as possible the three ulcer forces. Unfortunately we have no means of controlling the direct cause, or *x*, nor can we as yet abolish the individual predisposing causes. That leaves us to concentrate on the third factor, namely, acid, and our procedure should aim to eliminate it.

Finally, after removing the ulcer and after abolishing hydrochloric acid, we must correct any functional disturbances that have resulted from the ulcer, and leave our patients once more unconscious of the fact that they possess a gastro-intestinal tract. No less than this should be our ideal. To condemn them to a life of inhibitions can never be synonymous with a cure. That is but a confession of our weakness, necessary perhaps in various stages of progress. But it can never be the goal. We should examine all our surgical procedures from the foregoing points of view.

SUMMARY

1. There is an individual predisposition to ulcer. Evidence in favor of such a view is advanced mainly from studies of the autonomic nervous system.

2. Hydrochloric acid is a necessary factor in the production of a chronic peptic ulcer. It is shown that the hyperchlorhydria and

29. Crohn, B. B.; Weiskopf, S., and Aschner, P. W.: The Life Cycle of Peptic Ulcer, Arch. Int. Med. **35**:405 (April) 1925.

achlorhydria of the test meal may not be a measure of the hydrochloric acid secreted but rather of a disturbed motility of the stomach and duodenum. Pure gastric juice has a free hydrochloric acid of from 95 to 135, and anacidity may be the result of complete neutralization of all acid secreted.

If we call the direct etiologic factor of the ulcer x, then we may say that an ulcer results when:

x + hydrochloric acid + individual predisposition > defensive powers + reparative powers.

The natural powers may in some cases effect a spontaneous cure, and on the other hand in some cases they never do even if aided by the physician or surgeon.

4. From the surgical point of view all those methods may be termed "indirect" which do not deal with the ulcer directly, but which aim to so alter conditions as to bring the natural forces into the ascendancy and thus effect a cure. At present nearly all the indirect methods whether medical or surgical seek to do this by diminishing the acid factor.

5. Since only a direct method, that is, a method which at once solves the problem of healing by excising the ulcer, can at present approximate an ideal percentage of cures, the ideal method should include such a procedure.

6. The prevention of a recurrence of the ulcer should be attempted by permanently, if possible, altering the values of the foregoing equation, for instance, by the elimination of the hydrochloric acid.

7. At the same time the gastro-intestinal tract must be left in a functionally adequate condition.

A REVIEW OF UROLOGIC SURGERY

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KIDNEY

Surgical Treatment of Nephritis.—According to Kümmell,[1] Harrison in 1896 undertook the first operative attack on nephritis. Israel reported fourteen cases in 1899 in which nephrectomy had been performed for bleeding and renal pain. In 1901, Edebohls advocated the operation of decapsulation of both kidneys as a therapeutic measure in chronic nephritis. Following this work, numerous articles have appeared from time to time reviewing experimental work on animals and clinical results in human beings. Kümmell feels that the clinical results argue in favor of the procedure in spite of the fact that the experimental work is somewhat controversial. The good effect of decapsulation is probably due to the removal of the sympathetic nerve fibers which are severed from the kidney by removal of the capsule. The establishment of collateral circulation and the formation of a new capsule, which takes place rather readily, can only in part account for the favorable results.

Two procedures are most often applied, nephrotomy and decapsulation, while nephrectomy is less frequently performed. Kümmell reviews the clinical results of these operations in the several forms of nephritis. The acute nephritides are first considered. The nephritis of scarlet fever presents a type of renal swelling comparable to glaucoma in the eye. A case is cited in which unilateral decapsulation in an anuric patient led to diuresis and ultimate cure. Nephritis following poisoning, such as occurs after taking mercury, has been relieved in four of twenty-five reported cases in which decapsulation was carried out. Edebohls first employed decapsulation in the nephritis associated with

1. Kümmell, Hermann: Die chirurgische Behandlung der Nephritis, Ztschr. f. urol. Chir. **17**:26-52, 1925.

eclampsia, and good results following the operation under such conditions are numerous. Acute infectious nephritis in which the kidney is riddled with multiple small abscesses (which Kümmell speaks of as "nephritis apostematosa") presents a problem. Kümmell feels that in such cases decapsulation or nephrotomy should be performed when the diagnosis is definitely established. The procedure of choice depends on the condition of the kidney and will have to be determined at the time of operation. Of thirteen cases handled by the conservative method of decapsulation, cure was effected in twelve. Trench nephritis in its more severe aspects, especially when hemorrhage, oliguria and uremia are impending, may frequently be brought to a favorable turn by decapsulation, and Kümmell feels that war surgeons were too slow in adopting the method. In considering the chronic cases great stress is placed on the favorable results in so-called nephritis dolorosa, or nephralgia. This group of cases is not scientifically defined, the chief symptom being pain in the renal or ureteral region with few or no clinical pathologic observations. Usually the disease is unilateral. There may or may not be slight diminution of function in the affected kidney, but on the whole the diagnosis rests mostly on the absence of demonstrable pain-producing renal disease. Kümmell recommends decapsulation in such cases and cites numerous instances in which it has afforded relief. The hemorrhagic nephritides constitute another group of cases in which surgical intervention may be undertaken. Particular attention is paid by Kümmell to the cases of essential hematuria. He reviews the present day ideas on the subject and reports his operative experience. Of forty-two cases in which operation was performed, nine were associated with nephritis dolorosa. Nephrotomy was performed in fifteen, nephrectomy in three, and decapsulation in twenty-four, in four of which the operation was bilateral. Of the twenty-four patients, fifteen were discharged as almost cured, eight as improved, and one died fourteen days after operation from pneumonia. Thirteen of the twenty-four cases were traced. In only two of these was there further bleeding.

The cases of chronic interstitial nephritis form a more debatable group for surgical intervention. However, the work of Edebohls, Quiteras, Oliver and Volhard is cited as being evidence of the value of the operation of decapsulation. Rovsing's [2] report of operation in 157 cases, of which seventy-seven were his own, is encouraging. Thus, fifty-three of sixty-two patients with interstitial nephritis were cured, eighty were improved and one died. Of fifty-six patients with granular nephritis twenty-four were cured, twenty-one were improved, two

2. Rovsing, T.: Chirurgische Behandlung der Nephritiden, Ztschr. f. urol. Chir. **15**:210-211, 1924.

manifested no change and nine died. Eight of twenty-four patients with nephrosis were cured, nine were improved, four showed no change and three died. Of nine patients with glomerulonephritis, four were cured, four were improved and one showed no change. Six patients with orthostatic albuminuria were cured. The follow-up records of eighty-eight of Rovsing's cases showed complete cure in forty-three after from five to twenty years, improvement in thirty-eight, and no change in seven. In Kümmell's clinic, forty-seven patients with medical nephritis were operated on; unilateral decapsulation was performed in twenty-eight cases, and bilateral decapsulation in five. Ten of these patients died after a short period of improvement, twelve were cured, eight were discharged improved and three were unimproved. Nephrostomy was performed in nine cases with death in two, no relief in two, and cure or improvement in five. Nephrectomy was performed in five cases with cure in three and no relief in two. Thus, of forty-seven patients who underwent operation, eighteen were cured, eleven were improved and five manifested no change; of the thirteen who died, one underwent nephrectomy eight months after operation, during which time he had been able to work. Kümmell concludes that the operative treatment in many forms of nephritis is followed by good results in many cases.

[ED. NOTE.—This article by Kümmell and that by Rovsing, appearing from two different parts of Europe in the same year, suggest the interest that is taken in decapsulation, and should encourage surgeons and internists in this country to attack nephritis by this method more frequently. Probably decapsulation is effective because it in part removes the nerves from the kidney as renal sympathetic neurectomy does. Rovsing reports 157 cases of nephritis in which surgical treatment was instituted over a period of thirteen years. The operative procedure carried out in most of his cases was nephrolysis, that is, shelling the kidney out from its capsule of fat and connective tissue. In cases of severe hemorrhagic nephritis, in which nephrectomy is usually believed to be indicated, nephrolysis might be a better method. This operation is carried out through a lumbar incision; the kidney is stripped from its fatty capsule; the membrana propria is lifted up and incised near the convexity of the kidney and stripped off by means of blunt dissection to the renal hilum. A cigaret drain is left in the wound. Moderate drainage of serum for a few days and healing without complication result as a rule. The end-results show healing and improvement in most cases.]

Anomalies.—Schillings [3] reports a case of congenital absence of one kidney. This condition occurs in about one in 2,500 persons. About

3. Shillings: Anomalies renales, Le Scalpel, 1926, no. 9, pp. 193-196.

300 cases have been reported, most of which were discovered at necropsy. Papin has reported two cases in the living subject, but they were not proved by operation. Schillings has seen a similar anomaly in a woman, aged 33, which was diagnosed clinically and confirmed at operation. The patient had two children; she had never been ill until two years before admission, when she noticed a vague pain in the left lumbar region toward the abdomen and the thigh. Cystoscopic examination revealed the absence of a left ureteral meatus. From a diagnostic standpoint, one should in such cases keep in mind the possibility of congenital or acquired atrophy of the kidney, occlusion of the kidney, a kidney without a ureter or a ureter with an extravesical outlet. Papin says that the cytoscopic examination is extremely important and should be repeated several times. If this procedure does not confirm the absence of one ureteral orifice, a Garceau ureteral catheter is inserted in the normal ureter and the bladder drained with a second catheter left in the bladder to make certain that it does not contain urine. This procedure was followed in Schillings' case. The vesical catheter remained empty, the ureteral one giving 198 cc. of urine in one hour and ten minutes and a 60 per cent return of phenolsulphonphthalein. The diagnosis of absence of one kidney was made, but, as the patient complained of persistent pain in the left lumbar region, the area was explored surgically. No kidney was found, either in its normal situation or in the pelvis. Pain was not relieved and could not be explained.

Boss [4] reports a case of horseshoe kidney diagnosed preoperatively, and he believes that most cases should be diagnosed thus. Israel and others state that most horseshoe kidneys are diagnosed at operation. In the physical examination, palpation gives the best information. The phenomenon of palpation-albuminuria has only a limited value. While cystoscopy and uretral catheterization in themselves are not especially important, pyelography may yield much information, especially as to the shortening and median position of the ureters. The roentgenogram will, of course, be of more value if the connecting bridge can be demonstrated. Additional information can be obtained from bilateral pyelography, since by such a procedure the V-forming axis of the horseshoe kidney as well as the relative position of pelves to ureters can be determined.

[Ed. Note.—Diagnosis established prior to operation is a distinct aid to the surgeon. Rovsing observed that if the patient is placed so that the curvature of the lumbar spine is increased, or the back muscles made tense, a characteristic pain may be caused which may be relieved when he lies down. This so-called Rovsing sign has not, however,

4. Boss, William: Zur Diagnose der Hufeisenniere, Ztschr. f. urol. Chir. **19**:15-27, 1926.

proved to be of much diagnostic value. A fused kidney, unless abnormally enlarged, can seldom be recognized on abdominal palpation. Any tumor involving the median-lying segment of a fused kidney will usually present a mass in the umbilical area. Therefore, if a mass is palpable in the middle of the abdomen, the possibility of fused kidney must be considered. Occasionally, with a low-lying fused kidney, a retroperitoneal mass may be felt through the rectum, with the pulsation of adjacent large blood vessels. Fused kidney was observed in several patients with a urinary sinus in the middle of the abdomen anteriorly; these patients had had so-called abdominal abscesses drained elsewhere. Low or median hydronephrotic sacs, or their postoperative anterior sinuses, should suggest fused kidney. In the presence of lithiasis, the resulting roentgen-ray shadow may be in a position more median than is usual with renal stone. It has been our experience, however, that a stone in the fused renal pelvis often casts a shadow approximately in the normal position. With multiple stones, the shadows may extend across the vertebrae. Shadows cast by calcified paravertebral glands, low or median-lying gallstones, and stones in the upper ureter are most easily confused with those of stones in a fused kidney. If the shadow of a stone lies in an oblique angle and extends toward the median line, it should be regarded as suggestive of fusion. Pyelographic evidence alone may lead to the recognition of fusion. Because of the scarcity of definite clinical data suggestive of fused kidney, its clinical diagnosis is usually made only in the course of routine pyelography. The characteristic finding is the inverted relative arrangement of the calices and the true pelvis. Instead of lateral extension of the calices, there is median or cephalad extension due to torsion of the renal pelvis. Also the ureteropelvic angle, which is usually median to the pelvic outline, is situated laterally. Therefore, when the pyelogram shows evidence of renal torsion, the possibility of fused kidney should always be considered. The identification of shadows and the other conditions usually brought out by the pyelogram also afford diagnostic evidence.]

Haas [5] says that horseshoe kidney is one of the most common renal anomalies. Urinary obstruction is usual and consequently its sequelae, hydronephrosis, pyonephrosis and stone, are frequently found. Tumors occurring in horseshoe kidney are rare and usually occur in the right half of the renal mass. A patient, aged 45, had three different tumors in a horseshoe kidney. He had pain on the right side, fever and hematuria. At one time the hematuria was marked. Cystoscopic examination revealed a vesical papilloma, which was destroyed by fulguration. Because of a large palpable tumor of the right kidney the patient entered the hospital, where cystoscopy revealed a gaping right ureteral orifice

5. Haas, N. C.: Tumoren in Hufeisennieren, Ztschr. f. Urol. **19**:81-86, 1925.

spurting blood tinged urine. The urine and the function on the left were normal. At operation a horseshoe kidney was found on the right. It was exposed and found connected to the left by an isthmus. The right half was resected. Pathologic examination showed a large hypernephroma of the upper pole, an adenoma in the lower part, and a papilloma in the pelvis.

[ED. NOTE.—Mixed tumors of the kidney are rare. Graves recently reported several cases, and a number have been reported in foreign periodicals. Tumors occur in horseshoe kidneys relatively more frequently than in normally situated separate kidneys. In view of the rarity of renal fusion, the number of tumors reported occurring in horseshoe kidneys is comparatively large. The usually associated urinary obstruction, pelvic distention and infection favor the formation of inflammatory types of tumor, such as renal papilloma, of which several cases occurring in fused kidney have been reported.]

Hellsten [6] reports a case of resection of the left hydronephrotic half of a horseshoe kidney. The parenchyma of the isthmus was cut along the groove. Hemorrhage was slight and was stopped by a row of catgut sutures. The top part of the ureter was firmly fixed for a distance of 2 cm. to the pelvic wall. Three years after operation the patient was quite well.

There is a marked tendency for horseshoe kidney to become the seat of morbid changes. Hellsten reviewed 107 cases in which horseshoe kidneys were operated on for various diseases (accompanying table).

Cases in Which Operations Were Performed on Horseshoe Kidney (Hellsten)

Diseases	Cases	Per Cent
Hydronephrosis	29	27
Pyonephrosis	13	12
Nephrolithiasis	32	30
Nephritis, pyelitis, perinephritis	10	..
Tuberculosis	9	..
Tumor	8	..
Renal cysts	3	..
Trauma, hemorrhage	3	..

It is found that a substantially higher percentage of these diseases is included among those associated with horseshoe kidneys than among those of the normally formed kidney. This applies especially to hydronephrosis. The operations for hydronephrosis, pyonephrosis and stone in the kidney constitute about 70 per cent of all operations on the horseshoe kidney as against 30 per cent of all operations on the normal

6. Hellsten, O. T.: A Case of Hydronephrosis in a Horseshoe Kidney; Heminephrectomy, Acta chir. Scandinav. **59**:415-426, 1925-1926.

kidney. It would appear that hydronephrosis, from which pyonephrosis may arise secondarily, and nephrolithiasis are by far the most common diseases connected with horseshoe kidney. In rare cases a horseshoe kidney can be recognized by palpation, and also roentgenologic examination (Voorhoeve). If the roentgenogram shows the kidneys to be low, displaced medially, and with one or both of the longitudinal axes parallel to the vertebral column, or even converging downward, this is indicative of the presence of a horseshoe kidney. Voorhoeve suggests the possibility of getting a roentgenologic shadow of the connecting bridge. In this case the diagnosis of a horseshoe kidney is assured. In pyelography the shadows of the pelvis also show displacement in the same direction, namely, downward and medially. If this is shown on one or both sides, and if there are signs of torsion, the pelvic shadow lying with its convex margin directed laterally and calices medially, the possibility of a horseshoe kidney must be considered.

[ED. NOTE.—Hellsten's data show that hydronephrosis and pyonephrosis frequently occur with horseshoe kidneys. The high insertion of the ureter and the sharp ureteropelvic angle provide inefficient drainage for the renal pelvis; this, together with the unsupported and readily distensible pelvic walls, makes dilatation common. Hydronephrosis and its sequelae, infection and the formation of calculus, are the most common conditions requiring surgical treatment. The distention is often tremendous, and may occur in both kidneys; it is manifested by a tense, fluctuating mass in the abdomen near the median line. The mass is generally freely movable, not tender and moves with respiration. Various surgical procedures have been carried out in endeavors to readjust drainage of the distended kidneys, but in most cases complete removal is indicated. Aspiration of the hydronephrotic mass through the abdominal wall may be followed by persistent drainage or a fatal peritonitis. Abnormally situated horseshoe kidneys sometimes become infected with tuberculosis bacilli. The opposite kidney may also be the seat of disease, either infection or calculus formation. The tuberculous infection may extend to the isthmus, but this does not contraindicate radical treatment, although the operation may be complicated by a long standing fistula.]

Tuberculosis.—Joly [7] asserts that urologists are unanimous in advising early operation for renal tuberculosis. Rafin compiled statistics of 168 patients who had not been operated on, and whose history was traced either by himself or by the patients' physicians. At the time of the inquiry, ninety-one were dead and seventy-seven were alive. Twenty-nine of the first group died within two years from the onset

7. Joly, J. S.: The Late Results of Renal Tuberculosis, Brit. J. Tuberc. **19**:188-195 (Oct.) 1925.

of the disease, thirty died in the next three years, twenty-seven died between the sixth and the tenth years and only five lived more than ten years. Eighteen of the second group had had the disease less than two years, nineteen had had it between three and five years, twenty-eight between six and ten years, and twelve more than ten years. Rafin also noted the cause of death in seventy-four cases; in only four it was due to intercurrent disease; in the others it was the direct result of either local or generalized tuberculosis. The disease appeared to be more chronic in the female than in the male. The males who died had the disease on an average of three and three-fourths years, and the females five and three-fourths years. The males who did not die had the disease on an average of four years and four months, and the females five years and five months. The difference may be due to the tendency for the infection to spread to the genital organs in the male. Wildbolz compiled information regarding 316 nonsurgical cases of renal tuberculosis; 218 patients were dead and ninety-eight were alive. Ninety-nine of the patients lived less than two years, eigthy-six lived between three and five years, twenty between six and ten years, eight more than ten years; in five cases the duration was not noted. With few exceptions all these patients died from tuberculosis. Sixty-eight of these ninety-eight patients still suffered from severe symptoms of urinary tuberculosis. Clinical cures of nonsurgical renal tuberculosis are exceedingly rare. On the other hand, surgical intervention is often successful.

Falci[8] studied fifty cases of renal tuberculosis in which treatment was given in Marion's service in the hospital Civiale; the patients were less than 18 years of age. He found that the disease was less common in the child than in the adult. The frequency increases directly with the age and reaches its acme between the ages of 13 and 18. The comparative frequency of bilateral cases is higher in children than in adults; in the first years of life it is twice as frequent (28 per cent in children and 14.12 per cent in adults). The infection is bilateral in all cases of children from 1 to 6 years; in 50 per cent from 7 to 13, and 20 per cent from 14 to 18. The disease in children is usually rapidly fatal. The prognosis following operation is also bad; Falci found that 44 per cent of children died after nephrectomy; 16 per cent were worse than before operation; no change was observed in 10 per cent, and cures were obtained in 24 per cent. In adults the period of maximal frequency of renal tuberculosis is between 19 and 30 years. Bilateral infection is much less common in adults than in children; it progresses less rapidly as the reaction of defense is more active. The results from nephrectomy are excellent. Hogge reports 56 per cent absolute cures. Falci con-

8. Falci, Emilio: La tuberculose renale de l'enfant (fréquence, évolution, prognostic) comparée a celle l'adulte, J. d'urol. **20**:301-317, 1925.

cludes, as does Marion, that infantile renal tuberculosis in children is a grave disease, much more serious than in adults.

Tumors.—Laqueur [9] describes two cases of pyelitis polyposa and comments on the rarity of polyps in the ureteral and pelvic mucosa as compared with the same condition elsewhere. Lebert, Rayer and Albarran have all reported cases. Seven of ten authors believe the condition to be the result of inflammatory hypertrophy; others believe there are no inflammatory changes. Three cases of pyelitis polyposa of the renal pelvis, two in Federoff's clinic, are reviewed. In each instance the condition was associated with stone, which suggests an inflammatory cause. The differences occur in the structure. In one case (Viannay's), the new growth consisted of young connective tissue without evidence of inflammation. In Federoff's cases, it consisted of granulation tissue which changed to firm fibrous tissue toward the center; it was rich in blood vessels; in Federoff's first case, little cell element was present and in the second there was much.

[ED. NOTE.—This discussion of pyelitis polyposa and polypous fibroid brings up the question of the relationship between low grade chronic inflammatory irritation and excessive regeneration of tissue in response to such irritation. Whether such polypoid overgrowths are to be considered true neoplasms or tumors involves the fundamental problem of the cause of neoplasia in general. The modern trend of opinion among pathologists is to assume that most new growths are stimulated to some extent at least by inflammatory or biochemical irritants acting over a long period of time. If this is true, the conclusion that the type of lesion described here lies at the borderline between inflammatory hypertrophy and true neoplasia is probably correct.]

Maybury and Dyke [10] report two cases illustrating unusual manifestations of the power of the papillomas of the urinary tract to spread by implantation. In the first case, the original papilloma occurred in the renal pelvis, and implantation took place on the walls of the resulting hydronephrotic sac. Removal of the affected kidney together with the tumor was followed by the rapid growth of a malignant tumor in the remaining kidney. The urine contained much pus. In the second case, after removal of a simple vesical papilloma, three "graft-recurrences" occurred in three separate places in the tissues of the abdominal wall, appearing in rapid succession after removal of the first one. It is suggested that all three arose from portions of the original tumor accidentally implanted at the first operation. The primary tumor was

9. Laqueur, B.: Ueber polypöse Fibroide des Nierenbeckens, Ztschr. f. urol. Chir. **17**:205-212, 1925.

10. Maybury, B. C., and Dyke, S. C.: Some Unusual Manifestations of Spread by Implantation of Papillomata of the Urinary Tract, Brit. J. Surg. **13**:377-385 (Oct.) 1925.

histologically nonmalignant, but the successive recurrences showed a steady progress toward malignancy. It is suggested that the course of these cases offers an illustration of the inhibitory effect exercised by the presence of a primary tumor in the tissues on the rate of secondary growths, and their degree of malignancy.

Hydronephrosis.—When Rayer first described hydronephrosis it was assumed that the masses were voluminous liquid tumors developing in the renal pelvis. Papin [11] designates the condition hydronephrosis if the pelvis dilates to a capacity of from 20 to 30 cc. Such small distentions cause intermittent painful crises and the reflex vomiting so characteristic of large hydronephrotic sacs. The renal area appears normal in roentgenograms, but pyelography provokes the crisis. Careful examination of the pyelogram reveals slight variation from the normal. Papin believes that several sources of error could be avoided in making a diagnosis when there is only slight pelvic distention. By passing the catheter too high one may eliminate the kinks or folds of the upper ureter. Slight hydronephrosis should not be confused with ureteropyelonephritis, with which there is atonic dilatation of the upper ureteral segments; usually pyelonephritis may be recognized by pus cells in the urine. The treatment should be conservative, either nephropexy or enervation of the kidney. Papin considers the latter the most satisfactory operation if the hydronephrosis is slight and painful.

Marion [12] divides his cases of slight, painful hydronephrosis into two types. The first type is caused by an abnormal vessel kinking the ureter. Marion has observed fifteen cases of this type in which section of the abnormal vessel cured the patient completely. There is no obvious cause for the second type. Papin believes that enervation or section of the renal nerves would cure the patients, but Marion does not favor this. He believes that enervation may suppress the pain but will not influence the cause of the disease. In nine cases of this type he obtained cure by liberating the ureter at its superior portion and fixing the kidney as high as possible. Marion thinks that some cases are not due to a narrowing of the ureter, but to a too great fixity to the surrounding cellular tissue and to slight ptosis of the kidney.

Mercier [13] concludes from his experience of the etiology and treatment of slight hydronephrosis that most cases are produced by pelvic or ureteral membranes and lowering of the kidney a distance of from 1 to 2 cm. for some undetermined cause. The juxtapelvic portion of

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11. Papin: Les petites hydronéphroses douloureuses et leur traitement, Presse méd. **2**:1462, 1925.

12. Marion: Le traitement des petites hydronéphroses douloureuses, Bruxelles Méd. **5**:1412-1413, 1925.

13. Mercier, O.: A propos de la pathogénie et du traitement des petites hydronéphroses dites sans cause apparente, J. d'urol. **20**:467-482, 1925.

the ureter being fixed by membranes which are probably congenital in origin, the pelvis becomes either horizontal or oblique, and this tends to create a pelvic fundus. As a consequence of this position, the pelvis must increase the power of its contractions in order to empty normally, which in turn diminishes its contractile power; urine accumulates and hydronephrosis results. The surgical treatment should be conservative. One must abandon pyeloplasty and pyelo-ureteral anastomosis. Renal enervation, which is theoretically an efficacious means of relieving pain, is a delicate operation, at times endangering the renal blood supply, especially when there are pelvic adhesions. The operation is still too recently conceived to determine what its late effects on the kidney and pelvis might be. High nephropexy with liberation of the ureter is, on the contrary, easy and efficacious. It is a logical operation because it reestablishes the normal position of the pelvis toward the ureter. In all Mercier's personal cases the cure was complete and definite.

Gérard [14] reported at the twenty-fifth Congress Francais D'urologie a case of "giant hydronephrosis" of the left kidney, which slowly and progressively developed during successive pregnancies. Ureteral catheterization showed that the right kidney was normal, whereas no liquid could be withdrawn from the left side, although the unusual size of this kidney had been ascertained at the time of the last pregnancy. Two hundred cubic centimeters of sodium bromide solution was injected for pyelography. The patient had a severe reaction, which lasted three days and was accompanied by a marked distention of the hydronephrotic sac. The sac evacuated spontaneously and all symptoms disappeared.

White,[15] in a study of hydronephrosis, found that hydronephrosis with dilatation beginning at the ureteropelvic juncture is the commonest form of the disease. It is both congenital and acquired. Dilatation which advances more rapidly in the calices than in the pelvis is often due to obstruction in the lower urinary tract or to stone in the pelvis. Various abnormalities in the development of the kidney and ureters are reported in connection with hydronephrosis; however, it is not fully understood just how much abnormalities act to favor the development of the condition.

In a large proportion of the cases identified in the fetus and young children, and which are undoubtedly congenital, the dilatation is bilateral and often affects one ureter or both ureters; in some fetuses the lumen is completely obliterated. Usually the first manifestations are in adult life, between the ages of 20 and 30. In many such cases, the kidney is in an

14. Gérard, Maurice: Hydronéphrose géante; incidents consécutifs à une pyelographie, Presse méd. **2**:1463, 1925.

15. White, H. P. W.: The Pathology of Hydronephrosis, Brit. J. Surg. **13**: 247-279 (Oct.) 1925.

extremely early stage of dilatation. It is therefore assumed that such cases represent the acquired form of the disease. The earliest cases show narrowing of the ureter from chronic inflammation, which appears to be the cause of the dilatation. In all cases, pyelitis and some chronic interstitial nephritis are associated. Exacerbations of the pyelitis will explain the attacks of pain which come on without apparent cause in most cases. Usually there is evidence of the infection, either on cystoscopy or in the urine, during an attack of pain, when there is often increased frequency of micturition; this evidence may disappear with the attack. Chronic or severe acute inflammatory disease in any part of the body, chronic gastro-intestinal derangement and the pyelitis of pregnancy are common antecedents of hydronephrosis.

The Dietl's crises sometimes observed in cases of movable kidney are no doubt due to renal retention, not from an obstructed outlet of the pelvis but from a congested kidney resulting from pyelitis consequent on chronic intestinal trouble so often present with general visceroptosis, of which the nephroptosis is a part. Many cases in which there is a history of repeated crises fail to show any indication of a dilated pelvis on operation. Tuffier, in describing the results of nephropexy for attacks of pain in forty-five cases, could find no evidence of dilatation in thirty-six. Geraghty and Frontz quote the combined data of seven authorities on 4,576 cases. These show that mobile kidneys occur in 20 per cent of women and in 2 per cent of men. They also refer to Kelly and Burnam, who found the mobile organ on the right side in 177 out of 245 cases, on the left in twenty-five, and on both in forty-three. White points out that if mobile kidney were the cause of hydronephrosis we should find an overwhelming number of cases in women, the right and double hydronephrosis being more common than the left. None of these facts, however, has been substantiated, for the disease is twice as common in women as in men; it occurs with equal frequency in either kidney, and it is rarely bilateral. Moreover, mobile kidney is markedly preponderant in the fourth decade while hydronephrosis is usually preponderant during the third decade.

Polycystic Kidneys.—Davis [16] believes polycystic kidney to be the most important congenital defect occurring in the renal organs. This anomaly, like others of the renal organs, may be associated with other developmental stigmas. It may be present in the fetus, in the new-born child, or even in old age as late as the ninety-eighth year. The liver may also be similarly affected. The subjective symptoms are mainly renal insufficiency, hematuria, pain and infection. A mass in the region of one or both kidneys, if nodular, suggests polycystic kidneys. Increase in

16. Davis, J. E.: Congenital Polycystic Kidneys, Am. J. Obst. & Gynec. 9: 758-783 (June) 1925.

blood pressure usually depends on the force necessary to propel blood through the vessels which have constricted lumina due to the enlarging cysts. The specific gravity of the urine is usually low. Other symptoms comparable to interstitial nephritis may also be present.

Nephrolithiasis.—Hofmann [17] reports a case of gigantic renal calculus. The patient, a man aged 29, had had symptoms of renal stone for ten years. At operation the renal pelvis was markedly enlarged and the stone was removed through an incision in the pelvis which extended up into the renal parenchyma. The pelvis was drained. The stone was 10 by 18 cm., porous in structure and composed of pure ammonium magnesium phosphate.

Reflex Anuria.—Nicolich [18] reported a case of anuria following the removal of a right pyonephrotic kidney. The left kidney was found to be normal before operation. Catheterization yielded a small quantity of purulent urine. The patient's condition becoming rapidly worse, it was decided to operate, and the remaining kidney was decapsulated. The kidney was slightly enlarged and pale. A microscopic examination of a removed section did not reveal pathologic alterations. In the first twenty-four hours only 180 cc. of urine was passed, the second day, 1,000 cc. and the third day 2,000 cc. Recovery was progressive.

Nicolich concluded that the anuria was purely reflex, on account of the success of decapsulation, the histologic integrity of the left kidney, the normal urine passed after operation, and the excellent general health of the patient. Reviewing the urologist's and physiologist's opinions on the subject, he says that the origin of the reflex is to be found in the excitation of one kidney (renorenal reflex), of a ureter (ureterorenal), or of the bladder or urethra. The paths followed by the reflex are not known. Newrit thinks that it follows the splanchnic nerves, and reaches the medulla by the tenth, eleventh and twelfth thoracic nerves. Zoja thinks that its center is in the medulla between the seventh and eighth thoracic nerves.

[ED. NOTE.—Renorenal reflex has been widely discussed by continental surgeons. Most urologists in this country doubt the existence of such a condition. Usually the cases in which suppression is attributed to a reflex condition can be accounted for by a temporary lesion in the remaining kidney. After the removal of a tuberculous kidney, anuria for several days is not infrequent, and is usually due to a toxic nephritis. In one case in which death occurred following nephrectomy for tuberculosis, necropsy revealed an acute toxic condition without evidence of

17. Hofmann, Willy: Ueber einen Fall von ungewöhnlich grossem Nierenstein, Ztschr. f. Urol. **19**:881-884, 1925.

18. Nicolich, G.: Anurie réflexe après néphrectomie pour pyonéphrose. Décapsulation de l'autre rein. Guérison. J. d'urol. **20**:41-46 (July) 1925.

tuberculous infection in the remaining kidney. Not infrequently cases of anuria following nephrectomy are due to a mechanical or obstructive condition in the remaining kidney, which becomes effective on account of the increased activity of the organ. Morris reviewed a group of forty-eight cases of anuria in which no operation was performed, and a group of forty-nine cases in which operation was performed; ten (20.8 per cent) of the forty-eight patients recovered, and twenty-five (51 per cent) of the forty-nine recovered. The return of function in some of these cases after drainage of the renal pelvis is remarkable. In one case at the Mayo Clinic only 25 cc. of urine was passed over a period of fourteen days. After drainage of the pelvis 540 cc. was excreted the first seven hours, and 3,300 cc. the next twenty-four hours.]

Perinephritic Abscess.—Cirillo [19] studied bacteria from pus in five cases of perinephritic abscesses. In some cases the abscesses caused the usual symptoms, increased temperature, pain and swelling; in others there was an acute abdominal syndrome suggesting intestinal perforation. The abdominal symptoms have been well described by Legueu, Papin and others; at times they simulate acute intestinal obstruction or peritonitis. In each of Cirillo's cases, the bacteria were those usually found in the intestine. These, following increased virulence, may sometimes overcome the anatomic resistance of the intestinal coats and reach the perirenal tissue, either by the blood stream or lymphatic ducts. The organism which is best able to adapt its virulence to the new medium spreads rapidly and destroys any other associated organisms. Perinephritis, like appendicitis, may be caused by different bacteria, which are sometimes found in pure cultures; in other cases they are contaminated with other organisms. Usually the infection is multiple. The most important part is played by anaerobic organisms. *Bacillus perfringens* and *Bacillus coprogenes-foetidus* are the most frequent offenders, probably because they are more resistant than the others and adapt themselves quite readily to the conditions of living in the perirenal area.

Hematuria.—Blum [20] discussed massive hemorrhage from the kidney without obvious preoperative demonstrable cause. In one case such a hemorrhage was caused by a rare subcapsular myxofibrolipoma; in another the removed kidney showed a thrombosed varix with surrounding hematoma and vascular congestion. In one case of hypernephroma, which had not broken through into the pelvis, there was marked bleeding.

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19. Cirillo, Giuseppe: Recherches bactériologiques sur quelques cas de suppuration périrénale, J. d'urol. **20**:462-466, 1925.

20. Blum, Victor: Zur Diagnostik und Therapie renaler Massenblutungen, Ztschr. f. urol. Chir. **17**:169-186, 1925.

The pelvis contained a urate stone (the only case of primary stone in the pelvis with typical hypernephroma recorded). Blum considers as possible causes of massive renal hemorrhage: (1) trauma; (2) papilloma and papillary cancer of the pelvis; (3) early tuberculous ulceration involving the papillae (diagnosis difficult); (4) congenital cystic kidney (several cases reported relieved by ignipuncture); (5) hypernephroma (the most common cause), which usually invades the pelvis but may cause hemorrhage from pressure changes in the vessels without invading the pelvis; (6) renal and ureteral stones (rarely causing excessive hemorrhage); (7) nephritis (acute glomerular, scarlatinal, postinfluenzal and arteriosclerotic); (8) floating kidney and hydronephrosis (rare and when present due to sudden extrarenal pressure release with sudden draining of the hydronephrotic or obstructed kidney; this develops pressure changes in the blood vessels, which may cause vascular rupture), and (9) essential hematuria.

Blum analyzes the theories and various explanations of essential hematuria, and attempts to show that they can all be made clearer. Kretschmer's classic review of 129 cases is mentioned as evidence of focal glomerular nephritis being a cause in many instances. The experience of J. Israel, Zinner and Rubritius points to atypical nephritis, Fenwick operated in a case showing angioma of a renal papilla. Hofmann found the cause in a small papilloma a few centimeters from the ureteral orifice. Withney's case was explained by a papillary varix. In short, Blum holds that essential hematuria is not a good diagnostic term, and that the conception of an angioneurotic hemorrhage or unilateral renal hemophilia is not likely to be the correct explanation in the majority of cases.

[Ed. Note.—Few will disagree with Blum's list of causes of massive renal bleeding. The most important remaining point is to explain the essential hematuria group. It is true that the term "essential hematuria" is used too often to cover cases improperly diagnosed, but, on the other hand, there are many cases in which sufficient abnormality will not be revealed by cystoscopy, operation or necropsy to convince the pathologist that the cause of the bleeding lies therein. The term, nephritis, itself covers many and confusing conditions both from the anatomic and functional standpoints. So far as we know, no anatomic, histologic or functional criteria are as yet in evidence to account for the group of nephritides which is consistently accompanied by unilateral renal bleeding while the kidney remains in other ways functionally and anatomically approximately normal. Therefore, it would seem better to wait for the true significance of essential hematuria on a pathologic basis before insisting, as so many do, that the term be discarded.]

Blanc [21] reports several cases of pyelonephritis accompanied by hematuria. He has divided them clinically, into four groups: (1) acute pyelonephritis with cystitis and terminal hematuria; (2) acute pyelonephritis with renal hematuria, the hematuria taking place usually at the beginning of the crisis and lasting a short time; (3) acute hematuric pyelonephritis, in which hematuria is the predominant symptom, and (4) chronic hematuric pyelonephritis. Various bacteria may be the cause of this type of pyelonephritis. The infection, often unilateral, does not seem to alter the value of the kidneys, which later recover their anatomic and functional integrity. A differential diagnosis may sometimes be difficult, particularly if tuberculosis is present. It must be understood that this type of hemorrhagic renal disease is entirely different from what has been erroneously called hemorrhagic nephritis; this is never associated with pyuria. The prognosis is usually favorable, but in certain instances the long evolution and the quantity and frequency of hematuria may alter the patient's general condition and sometimes the kidney itself. Blanc states that simple ureteral catheterization is usually sufficient; the mere catheterization for the investigation of function will often stop a hemorrhage which has lasted for three weeks or more.

Pyelonephritis.—Luchs [22] offers a rather ingenious explanation of the mode of infection of pyelitis in pregnancy. He cites evidence to show that the bladders of many pregnant women contain bacteria which have gained entrance by ascending through the short urethra. He further recalls that ureteral reflux is found where the integrity of the ureteral orifice has been upset, or where the nervous or muscular mechanism of the ureter has been disturbed. In pregnancy the bladder is displaced by the growing uterus so that often the trigon lies in a position parallel to the symphysis pubis. Owing to the physiologic dextroposition and torsion of the pregnant uterus, the lower ureteral segment in the region of the iliac artery becomes kinked. Luchs believes that this may at times reach an angle of 90 degrees. Since as a rule the uterus rotates to the right, the lesion is usually on the right side. He shows several excellent cysto-ureterograms of the reflux.

Naujoks [23] in a series of eighty-one cases of pyelitis of pregnancy, found that three women aborted from the third to the sixth month of pregnancy. Thirty-four children were born from the seventh to the ninth months, and forty-three children were born at term. Of the thirty-four born prematurely, two died before birth, thirteen shortly

21. Blanc, Henry: De l'hématurie dans les pyélonéphrites, J. d'urol. **20**: 1-19 (July); 125-140 (Aug.) 1925.

22. Luchs, L.: Ueber den Infektionsweg der Schwangerschaftspyelitis, Arch. f. Gynäk. **127**:149-169, 1926.

23. Naujoks, H.: Die Aussichten für das Kind bei Pyelitis der Mutter, Zentralbl. f. Gynäk. **49**:1136-1139, 1925.

after birth, and two in a few weeks; five grew to maturity, two being normally developed, and three underdeveloped. Two of the forty-three full-term infants died before birth and two postpartum.

The action of the toxins and the spread of bacteria, as well as the irregular fever, must be considered as the cause of premature births. Two cases are cited. In one, that of a dead fetus, there were colon bacilli in the heart blood as well as in the placenta. In the second case, there were bacteria in amniotic fluid, placenta, and in the blood of the umbilical cord, but none in the heart blood. Colon bacillus conjunctivitis was also noted in one fetus.

[Ed. Note.—This is a convincing and concise review, and indicates the malignancy of the pyelonephritis of pregnancy which is usually regarded as a comparatively innocuous infection. About one third of the eighty-one cases resulted in the loss of the child. Pyelonephritis is comparatively common; many cases are mild and do not cause sufficient symptoms to require treatment. The high mortality in this series is in part accounted for by the fact that in the cases reported the infection may have been very severe.]

Typhoid Infection.—Patch [24] believes that infection of the kidney by typhoid bacilli is not especially uncommon. Such infection is hematogenous. In many cases in which the bacilli are excreted there is no obvious infection; its occurrence is, therefore, usually favored by some accessory local factor. The disease is usually bilateral, although in both of Patch's cases it was unilateral. It takes the form of cortical and intertubular suppurative processes in the renal parenchyma, with pyelitis. Occasionally ureteritis, cystitis and perinephritic abscess are also present. Miliary abscesses have been common in the acute, fatal cases, and pyonephrosis has occurred in a few. If patients survive the infection for any length of time multilocular pyonephrosis, and occasionally formation of stone, may occur. Multiple ureteral strictures were noted in one case. The infection may occur during the acute stage of the fever, during convalescence, or later. The course may be acute, but if the patient survives the condition may become chronic. Recovery was noted in only five of the cases of pyonephrosis, all unilateral and following operation. The symptoms in no way differ from those of other renal infections, and the diagnosis should offer no difficulties if modern methods of urologic examination are employed. Epidemiologically, patients with acute and chronic typhoid infection of the urinary tract are typhoid carriers and are even more dangerous to the community than patients with typhoid infection of the gallbladder.

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24. Patch, F. S.: Typhoid Infections of the Kidney, J. Urol. **14**:199-221 (Sept.) 1925.

Renal Enervation.—Serés [25] advises section of the renal nerves in certain diseases, such as slight hydronephrosis, in painful cases of nephritis and nephritis hematurica. He makes an ample lumbar incision, exposes the kidney and separates it from the renal fat. The renal pedicle is isolated so that its elements are completely visible. The anterior and posterior pedicular nerves are isolated and divided, and a partial decapsulation of the kidney performed. Serés has performed the operation in a number of cases, in the majority of which there was relief from pain. Because of one fatal case he has given up the operation, but he believes that if further studies show which nerves may be sacrificed and which should be preserved, the operation may be used again with great benefit.

[Ed. Note.—The operation of renal sympathectomy seems to be gaining ground among the European surgeons. Doubtless it has been stimulated by Leriche's work on periarterial sympathectomy. Milliken and Karr in this country have definitely shown that the nerves may be stripped from the renal pedicle with little or no permanent damage to renal function. This is somewhat in conflict with Serés' statement, based on the work of Bellido, that renal denervation, if bilateral, will lead to renal insufficiency and death of the animal. The work of Boeminghaus supports the contention of Milliken and Karr that experimentally bilateral denervation may be done without any permanent damage. The clinical picture of nephritis dolorosa and nephralgia is being more and more talked of in urologic literature. Of the actual motor mechanism of the function of the renal pelvis and ureter, its ability to go into nodal spaces with transient pelvic or ureteral dilatations, we know little. We do know that pain in the renal area without demonstrable renal lesions, and pain in the course of the ureter without stone or gross infection, may often be relieved by decapsulation of the kidney or by dilating the ureter with bougies. Hunner would probably feel that most of these cases belong in the ureteral stricture group and treat them by dilatation; Ambard and Papin, Legueu and Flandrin, Rovsing and Kümmell decapsulate the kidney or perform renal sympathectomy, and the results are good. Probably these methods will be adopted more universally in America, and in the next few years we shall have more clinical experience to help us in deciding the value of such procedures.]

Andler [26] concludes, from a careful and detailed study of clinical and experimental data, that after destruction of the nerve supply of the renal pelvis and ureter atony and dilatation result with consequent

25. Serés, Manuel: Enervation der Niere, Ztschr. f. urol. Chir. **17**:54-56, 1925.

26. Andler, Rudolph: Die Atonie des Harnleiters mit Dilatation und Hydronephrose, ihr klinisches Vorkommen und ihre tierexperimentelle Erzeugung, Ztschr. f. urol. Chir. **17**:298-357, 1925.

dynamic interference with the urinary outflow. Denervation of the renal pelvis and the entire ureter by itself does not bring about a disturbance of peristalsis. However, denervation of the renal pedicle causes the appearance of atony and dilatation of the pelvis and ureter. During denervation of the renal pedicle, as a rule there is an increase in the strength and frequency of the contraction of the renal pelvis and of the ureter. After complete denervation there is paralysis of the pelvis and ureter. Peristaltic movements cease entirely.

The dynamic interference with the urinary outflow is most marked in the first few days. If bilateral denervation is carried out at the same time the animal usually dies in uremia. The same result is obtained if one side is denervated and the opposite ureter is ligated. If bilateral denervation is carried out at different times, allowing an interval of a number of days, the animal usually lives. The urinary drainage on the denervated side undergoes improvement after a few days, and this increase continues up until about the fourteenth day. Then the lessened urinary outflow persists below normal. The peristalsis does not completely return to normal, and the propulsive force to the urine is insufficient. As a result hydronephrosis and hydro-ureter result.

The application of paravertebral or splanchnic procaine anesthesia, as carried out by Laiven and Neuwirt, temporarily relaxes the ureter in cases of impacted stone.

Andler warns against the possibility of hydro-ureter and hydronephrosis following the operation of Ambard and Papin, in which denervation of the renal pedicle is applied to human beings. The decapsulation operation of Edebohls is recommended as a better procedure in such cases, as it does not seem to have this inherent danger.

[Ed. Note.—Stimulated by the work of Ambard and Papin, and Flandrin, much work is being done on the renal and ureteral nerve supply, and the need of better means of treating painful kidneys and ureters that show little or no serious lesions is being recognized. The European writers assert that since the war the condition of nephritis dolorosa (a comprehensive though indefinite term) is on the increase.

The operation of renal periarterial sympathectomy, as brought out by Papin, has been regarded as a hopeful procedure to be used in the more difficult and obscure cases. Andler's work, therefore, comes in good time, and if his conclusions prove to be correct this operation will quickly fall into clinical disrepute. One should certainly perform such an operation with the knowledge that nephrectomy may be done safely later if necessary.]

Experimental Surgery.—Carson [27] reports his observations in experimental nephrotomies on dogs. He cites the work of Moore and Corbett,

27. Carson, W. J.: Experimental Nephrotomies, Surg. Gynec. Obst. **42**:53-57 (Jan.) 1926.

who found that an operation on the kidney damages the kidney, that the suture which controls hemorrhage does more harm than the incision, that the destruction of the kidney extends far beyond the site of operation, and that the functional activity of the kidney is usually reduced. Magoun, who performed experimental nephrotomy twenty-six times on twenty-three dogs, concluded that in fourteen of his experiments there was a reduction in the function of the kidney, which was proportionate to the amount of renal tissue destroyed. Carson found, in sixteen operations on dogs with both kidneys, that the line of incision up to fifteen days measured from 3 to 5 mm. in width, and from fifteen to 266 days it varied from 1 to 5 mm. in width. In nine nephrotomies on dogs from which one kidney had previously been removed, the bleeding time varied from two to ten minutes. Gross examination of this series of kidneys showed the scar to be from 1 to 2 mm. in width. In no instance was there any complication such as infarct, postoperative uremia, stone formation or fistula. In the twenty-five operations performed with interrupted sutures in the capsule, postoperative hemorrhage occurred once. Carson concludes that nephrotomy in dogs with interrupted Cushing sutures in the capsule is apparently a safe procedure. Cessation of bleeding is brought about by the production of a physiologic clot.

Holloway [28] performed a series of experiments on dogs in an attempt to determine the effect of diuretics, injected intravenously, on autogenous and homogenous kidney transplants. Autogenous transplants maintain viability and functional activity indefinitely, and the death of the animal or disturbance of function of the transplant is due to extraneous causes. The functional activity and also the secretion of such transplants are apparently similar if not identical with those of a normal kidney. The effect of diuretics is the same as in a normal kidney.

Homogenous transplants maintain only a transient viability, and their functional activity is usually short-lived. As long as they remain viable, they function in a manner similar to autogenous transplants. They tend to eliminate urine that in most respects is similar to urine secreted by normal kidneys. As a rule, however, the early appearance of albumin, red blood cells and pus denotes marked parenchymatous changes within the kidney. While functioning, the homogenous transplant tends to respond to a diuretic in much the same way as does a normal kidney, except that diuresis is not so marked or so prolonged. Loss of function and lack of response to diuretics are apparently directly in proportion to pathologic changes within the transplanted kidney. When function has ceased, the introduction of a diuretic is without effect.

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28. Holloway, J. K.: The Effect of Diuretics on Transplanted Kidneys, J. Urol. **15**:111-131 (Feb.) 1926.

URINARY INFECTION

Antiseptics.—Leonard and Frobisher [29] review the essential requisites of a satisfactory internal urinary antiseptic and state that hexylresorcinol most nearly fulfils these requirements. It soon became apparent that certain factors interfered with its antiseptic action. The first of these to be discovered was the administration of sodium bicarbonate, and the second was the routine practice among urologists of forcing fluids in the treatment of urinary infections.

Experimental data are cited which show that it is the surface tension changes and not the changes in the reaction of the urine which result from the administration of sodium bicarbonate that effect the potency of the drug.

Leonard and Frobisher find that the successful application of hexylresorcinol in the treatment of chronic infections of the urinary tract depends, therefore, on the strict observance of four factors, all of which bear a distinct relationship to the surface tension of the urine. The dosage must be adequate (0.6 Gm. three times daily); with smaller doses there may be insufficient reduction of the surface tension of the urine. The fluid intake must not be increased, for this not only dilutes the active hexylresorcinol in the urine but renders even that dilution less effective than it would be otherwise, by raising the surface tension. Sodium bicarbonate must be avoided, for this raises the surface tension of the urine so markedly as to rob it of its bactericidal properties. The course of treatment should be uninterrupted and sufficiently prolonged. The organisms which are most resistant to surface tension changes in the test tube (*Bacillus coli* group) are most resistant to the action of hexylresorcinol in the urinary tract. Chronic *Bacillus coli* infections ordinarily require from sixty to ninety days of continuous treatment on doses of 0.6 Gm. (four capsules) three times a day. Chronic coccus infections, on the other hand, may clear up completely with startling rapidity (forty-eight hours) and ordinarily require less than three weeks of treatment.

Braasch and Bumpus [30] review the results of chemotherapy. They find that of the various mediums employed with intravenous chemotherapy, mercurochrome-220 soluble has probably proved to be the most efficient. It is particularly effective in cases of acute and subacute infections of the urinary tract, and it has also been of great value in occasional cases of acute general sepsis of various types. In chronic

29. Leonard, V., and Frobisher, M.: Clinical Application of Hexylresorcinol in Urology, with Observations on the Significance of Surface Tension in Urinary Antisepsis, J. Urol. **15**:1-10 (Jan.) 1926.

30. Braasch, W. F., and Bumpus, H. C., Jr.: Clinical Results with Intravenous Chemotherapy in Urinary Infections, J. Urol. **15**:341-349 (April) 1926.

infections involving the urinary tract and other tissues it is not of great therapeutic value. The greatest objection to its intravenous use is its toxicity. Severe reactions are common, marked by prostration, chills and dysentery. Two of the 196 patients who received intravenous injections of mercurochrome-220 soluble at the Mayo Clinic during the last year died. Necropsy in one case demonstrated that, in the absence of any other cause of death, toxemia was the probable lethal factor. It is evident, therefore, that mercurochrome should be used intravenously only in emergency. Although the element of danger is ever present, nevertheless, in cases of acute sepsis, when other measures have failed, it merits trial. The number of spectacular recoveries reported following its use excludes the possibility of coincidence.

Hexamine was used in seventy-six cases of acute and subacute urinary infection, and was found to be useful in controlling symptoms and fever after manipulation in the urinary tract. Fischer's solution (sodium chloride 1.4 per cent and sodium carbonate 2 per cent) intravenously is indispensible in caring for certain cases of urinary obstruction with high blood urea value.

Helmholz and Field,[31] after extensive experimental study, found in the dosages used that hexamine is superior to mercurochrome-220 soluble and hexylresorcinol as a urinary antiseptic in cases of infection produced by *Staphylococcus albus* and *Bacillus coli*. *Staphylococcus albus* is much more vulnerable to the action of hexamine than *Bacillus coli*.

BLADDER

Tumors.—Damski [32] says that radical extirpation of the bladder with implantation of the ureters into the bowel for cancer of the bladder has adherents and opponents, but the mortality remains colossal. The operation of bilateral nephrostomy or ureterostomy is occasionally employed in cases of extensive inoperable cancer. The object of the operation is to relieve the patient of the pain incident to the passage of urine into the bladder and the contraction of the bladder in voiding. It is also thought to lessen the amount of coincident infection. Six cases are reported in which this operation was performed. Four patients were not relieved, and died soon. One was relieved definitely from tenesmus and pain, in spite of the rapid growth of the cancer with pelvic infiltration. In another case catheterization, after deviation of the urinary

31. Helmholz, H. F., and Field, R. S.: The Therapeutic Value of Mercurochrome, Hexamethylenamine and Hexylresorcinol in Cases of Experimental Urinary Infection in Rabbits, J. Urol. **15**:351-362 (April) 1926.

32. Damski, A.: Zur Frage der Harnableitung oberhalb der Blase bei inoperablem Blasencarcinom durch Nephro oder Ureterostomie, Ztschr. f. urol. Chir. **15**:50-51, 1924.

stream by the method described, yielded great quantities of putrid purulent material. No diminution in pain or tenesmus ensued. The patient died on the eighth day. Damski agrees with Legueu and Papin that the operation is useless, especially in cases in which there is muco-purulent secretion from a bladder that is filled with necrotic detritus.

[Ed. Note.—Last resort measures for extensive carcinoma of the bladder are usually fruitless. At best improvement is short and hardly commensurate with the pain and suffering incident to the operation. In spite of the high mortality, transplantation of the ureters, followed by total extirpation of the bladder, is the only procedure thus far advocated that offers a chance of even temporary relief in this type of case. When operation, or a series of operations, of such magnitude is indicated the malignancy is usually so widespread that hope of cure is abandoned, unless the surgeon is totally inconsiderate of operative mortality. A number of cases of complete resection of the bladder have recently been reported from Russian clinics by Federoff and Bystrow. In a series of 321 cases from the literature, the immediate mortality varied from 50 to 60 per cent. Federoff advocates a two-stage operation and an early radical operation.]

Diverticulum.—Jarosz,[33] after discussing the theories of diverticula of the bladder, says that congenital diverticula are usually single, consist of mucous membrane and muscular layers, and communicate with the bladder through a small opening; the musculature around the opening is occasionally strong enough to act as a sphincter. Acquired diverticula occur in later life, usually because of obstruction to the outflow of urine and an area of yielding of the weaker parts of the musculature of the bladder. Acquired diverticula are usually multiple; they consist of atrophied mucous membrane with a thinned-out or missing musculature and communicate with the bladder through a large opening. In spite of size, they may be symptomless for years, and are found only by accident or intervening urinary infection.

In examining the material in his clinic, Jarosz found only nine cases of diverticula among 181 cases of prostatic hypertrophy, sixty-one of tumor of the bladder, twenty-four of vesical calculi, and thirty of other vesical lesions. He believes that the cystoscope is of untold value in the diagnosis of these diverticula, and favors their treatment by radical resection.

Perivesical Infection.—Malatre [34] reports the case of a man, aged 67, who sixteen years before had had several slight attacks of hematuria. Recently the hematuria had recurred. He was markedly constipated and

33. Jarosz, H.: Zur Kenntnis der Harnblasendivertikel, Ztschr. f. Urol. **19**: 722-733, 1925.

34. Malartre, J.: Un cas rare de péricystite suppurée chez un vielil urinaire, J. d'urol. **20**:320-323, 1925.

had severe pain after urination. Cystoscopic examination revealed that the dome of the bladder was congested, and that there was bullous edema in the base, which was dotted with small nodules. The urine became more purulent after cystoscopic examination. During the course of a second cystoscopic examination there was a sudden small hemorrhage, followed by fetid cloudy liquid from the base of the bladder. A diagnosis of perivesical abscess was made. The urine became more cloudy, but the patient's general condition improved and the pain disappeared. Three weeks later he died from pulmonary complications. At necropsy, besides the lesions of bronchopneumonia and of bilateral nephritis, loops of the small intestine were found to be attached to the bladder. A small mass was found on the upper surface of the bladder; it was about 3 cm. in diameter and was lined by serous membrane and suspended in the abdominal cavity. There was marked infection extending along the ureters, and on the posterosuperior surface of the bladder a cavity was found which contained about 30 cc. of thick, foul smelling pus. This cavity was not lined by mucosa and was situated between the dome of the bladder and the detached peritoneum. It communicated with the cavity of the bladder by an irregular fistula, which opened into the dome. A small concretion was embedded in the peritoneal coat; this had probably been formed in a small cellule or pouch outside the bladder. It became infected and pushed the peritoneum upward and away from the bladder.

Calculi.—Stirling [35] asserts that dumb-bell stone of the bladder and diverticulum is rare. He reports a case in which stone had been removed from the bladder in 1918. In 1925 a stone of the dumb-bell type was found, the larger portion being in the diverticulum.

[ED. NOTE.—Urinary obstruction and the sacculation of infected urine are conducive to the formation of calculi. Dumb-bell and hourglass stones are occasionally seen; generally the larger portion of the stone is in the diverticulum. Diverticulum and stones in the bladder are often associated. Crenshaw and Crompton reported twenty-eight cases in which the two conditions were present. In thirteen cases the stone was in the bladder alone, in nine in the bladder and diverticulum, and in six in the diverticulum alone.]

PROSTATE

Hypertrophy.—Hunt [36] classifies the causes of death following prostatectomy in three groups: (1) preexisting and coexisting organic diseases; (2) surgical accidents, and (3) postoperative complications.

35. Stirling, W. C.: Recurrent Dumb-Bell Stone in Vesical Bladder and Diverticulum, J. A. M. A. **86**:478-479 (Feb. 13) 1926.

36. Hunt, V. C.: Treatment of the Surgical Patient Handicapped by Urinary Obstruction, Surg. Gynec. Obst. **42**:187-190 (Feb.) 1926.

Many causes of death are preventable. Prostatectomy is never an emergency procedure. In most instances urethral catheter drainage is successful and allows sufficient time to ascertain the physical status of the patient and then to determine the time of removal of the obstruction. The prostate should be removed only after the patient has recovered from the effects of obstruction. Coexisting renal insufficiency and cardiovascular disease are responsible for the majority of deaths following prostatectomy. Urinary retention with resultant renal insufficiency and subsequent uremia directly affect renal function and enhance coexisting cardiovascular and pulmonary diseases. This makes drainage of the bladder the most important treatment preliminary to prostatectomy. Preliminary treatment should be continued until the reaction to renal functional tests approximates normal. Hunt states that in most instances permanent drainage may be obtained through urethral catheterization. This limits the surgical procedure to one operation, which permits exposure, visualization and accurate hemostasis. In 1,783 prostatectomies performed at the Mayo Clinic, preliminary cystostomy was necessary in 437 (24.6 per cent). The mortality rate following prostatectomy at the Mayo Clinic for the twelve year period was 5.5 per cent; the mortality rate for the two-stage operation was 7.5 per cent, as compared with 4.8 per cent for the one-stage operation. The mortality rate following the one-stage operation was lower than that following the two-stage operation, by virtue of the better general condition of the patients selected for this method. The mortality rate following the two-stage operation would have been lower than it was had the two-stage method been employed as a routine in all cases. There were 113 deaths following operation in this series of cases, ninety-nine of which occurred within thirty days after operation. Thirty-three deaths followed two-stage operations; these patients were the poorer surgical risks. Twenty-two patients were prepared by permanent or intermittent urethral catheter drainage; forty-four had no preparation. In 50 per cent of the deaths in which necropsy was obtained death was found to be due to preexisting and coexisting disease; in 4 per cent it was due to surgical accidents, that is, hemorrhage and shock, and in 46 per cent it was due to postoperative complications. In 75 per cent of the deaths occurring when there had been no preliminary treatment, death was due to preexisting and coexisting organic disease. In 437 cases in which preliminary cystostomy had been carried out, the mortality rate was 7.5 per cent for the subsequent prostatectomy. In 666 cases there was no preparation, and the mortality rate was 6.6 per cent. In 680 cases in which urethral catheter drainage had been carried out, the mortality rate was 3.2 per cent. The mortality rate following prostatectomy on the best surgical risks without preparation approaches that of the exceedingly poor risks requiring cystostomy, and is twice that following the preparation of patients by urethral catheter drainage.

Walters [37] says that the condition of the patient does not depend so much on elimination from the body by way of the kidney, the intestine and the skin as on what remains in the blood and in the tissues. He reports 204 consecutive operations for prostatectomy, with only three deaths.

Without preliminary preparation, including control of urinary infection, and in the absence of studies of renal function to determine the capacity of the kidneys, the risk of a one-stage operation may be lowered by removal of the prostate through a perineal incision, on account of the dependent drainage and because the perivesical tissues have not been opened to infection. If the prostate is small and prostatitis is marked, the perineal operation may be expected to give good results. Previous operations on the bladder may cause contraction to the extent that the perineal approach to the hypertrophied gland becomes preferable. Postoperative ventral hernia complicating previous operations may favor a perineal operation, which can be performed without fear of opening the peritoneal cavity.

Walters believes that if the patient has been prepared so that prostatectomy can be safely performed it makes little difference, from the standpoint of the mortality rate, whether the gland is removed through a suprapubic or a perineal incision.

Bumpus [38] believes that the evidence obtained from cystograms is a reliable indication of the duration of the prostatic obstruction. If the obstruction has lasted for a short time, the deformity of the bladder is slight; if for a moderately long time, the outline is trabeculated and irregular, while if for a longer period, the bladder tends to become cone shaped and irregular in outline and one or more diverticula may be present. The amount of residual urine present indicates the extent of the obstruction. Cystoscopy should be avoided if possible, as the passage of any rigid instrument traumatizes the urethra. Cystoscopy is indicated if the symptoms are out of proportion to the prostatic enlargement. If the prostatic enlargement extends into the bladder rather than into the rectum, the cautery punch operation through the urethra is performed. In cases of impaired renal function with high residual urine the bladder is emptied gradually. Large amounts of fluid are administered by mouth and also by subcutaneous or intravenous injection. Following the administration of fluid, the patient is put daily in a hot pack and a profuse sweat induced. If a urethral catheter is tolerated, the preparation for operation may continue with this form of drainage. If the blood urea

37. Walters, Waltman: Physiological Principles in the Treatment of Benign Hypertrophy of the Prostate, Surg. Gynec. Obst. **42**:191-194, 1926.

38. Bumpus, H. C., Jr.: Preparation of Patients for Prostatectomy, Surg. Gynec. Obst. **42**:182-186 (Feb.) 1926.

decrease is slow and the patient's general condition is poor, a preliminary cystostomy is performed. With a two-stage operation a blind enucleation is necessary; this is a poor surgical procedure and is inevitably followed by inferior functional results. To undertake cystostomy in the presence of high blood urea is to diminish the possibility of the patient's recovery, since the added load to the reduced renal function imposed by the operation is more than can be withstood.

[ED. NOTE.—Bumpus' data on the value of the one-stage and two-stage prostatectomy are based on an experience with several thousand cases. His statement that the two-stage operation compels a blind procedure reflects the opinion of the Mayo Clinic. In other clinics, the two-stage operation is sometimes performed in such a manner that the second or blind procedure is eliminated, the tissues being well exposed, as in a one-stage operation. This, however, has the disadvantage of spreading the infection, which is always present, and sometimes of tearing the peritoneal fold. One of the most common causes of death in two-stage prostatectomy is peritoneal infection from a tear in the peritoneum. The one-stage visualized operation unquestionably gives a better functional result, but the average operator secures a lower mortality rate by the two-stage procedure.]

Von Illyés [39] calls attention to the frequency of recurrence of hypertrophy in nodes of prostatic tissue left at the first operation, and believes it is important to remove the prostate in one piece and to look over the field before finishing the operation, in order that no segments are left.

The familial tendency to prostatic hypertrophy is discussed. In one instance in von Illyés' series, a father and five sons had the disease.

In considering tests of renal function, von Illyés believes that Ambard's coefficient is untrustworthy. He relies more on the blood urea and the rest nitrogen as indexes of renal function. The borderline of operability in cases with renal impairment, when conditions fail to respond to drainage and return approximately to normal, is difficult to delineate. The blood freezing point is of great help, according to von Illyés; when it sinks to from 60 to 67 degrees below zero, the operation cannot safely be undertaken. In each case the general condition of the patient should be the criterion on which the surgeon must base his judgment. The presence of a firm node in the enlarged prostate is an indication for operation, as this may signify cancer or, sometimes, nonmalignant fibro-adenoma.

Thirty-nine deaths in von Illyés' series of 470 cases in which operations were performed are recorded. In the last 330 cases he used

39. Von Illyés, Géza: Ueber einzelne Fragen zur Therapie der Prostatahypertrophie, Ztschr. f. urol. Chir. **17**:229-242, 1925.

regional anesthesia of the epidural or caudal type. The technic of caudal block with infiltration to the abdominal wall is described. This has greatly reduced the operative mortality.

The suprapubic operation and the placing of a tampon and drainage tube in the prostatic fossa are described. The drain is usually removed on the fifth day. An indwelling catheter, placed at the time of operation, permits drainage and lavage of the bladder. The urethral catheter is removed about the twelfth day. Von Illyés cautions against exposure during operation of the prevesical space and consequent infection. In five cases of diverticulum of the vesicle, the sac was resected at the time of prostatectomy, with suture of the wall of the bladder.

Pericystitis is regarded as a serious complication. Epididymitis tends to appear about the second week, especially if the catheter is left in and there is marked urethritis.

The postoperative incompetency of the internal sphincter and the dilatation of the prostatic fossa, forming a sort of forebladder, are mentioned. Here necrobiotic tissue may become incrusted and cause persistent pyuria and dysuria, which can be relieved only by removal of the calcareous granulation tissue. This can be accomplished by means of the cystoscopic rongeur.

Distended and painful seminal vesicles are indicative of carcinoma in many instances.

Von Illyés favors a one-stage operation.

[Ed. Note.—Von Illyés' conclusions are in accord with those usually held by modern urologists of experience. There is some dispute as to the type of treatment of the prostatic fossa after prostatectomy, that is, whether it shall be merely sutured, or packed with gauze (around a drain or catheter), or distended with an apparatus such as the hydrostatic bag of the Hagner-Pilcher type, and when and how, and how long, to leave in a urethral catheter. Each of the methods is fraught with many possibilities for good or bad. The one significant feature of the Young perineal operation is the packing of the prostatic fossa from below and exterior to the capsule, as a means of hemostasis. This, it is believed, gives less chance for the development of the hour-glass bladder-prostatic urethra and wide stretching of the prostatic fossa.

As a matter of fact, the control of bleeding from the fossa after operation is not yet a perfected procedure. Each of the methods mentioned is widely used and usually successful. In general, the hydrostatic bag is the most accurate procedure for hemostatic control. The removal of the bag and insertion of the urethral catheter in one procedure simplifies the early postoperative treatment, and is usually the best plan for the surgeon.]

Keyes [40] reports an operation for the relief of incontinence following perineal prostatectomy. The perineum was opened in the line of the old scar, and the rectum separated from the urethra. There was almost complete destruction of the external urethral sphincter. As there was no other method of bringing pressure on the urethra, Keyes attempted to bring muscular pressure by suturing the two levators with the posterior part of the bulbocavernosus. The three muscles were brought together with chromic catgut by three interrupted sutures. They made a muscular bed, the bulbocavernosus holding the two levators snugly forward under the membranous urethra, on which the natural tension of the levators gave an upward tug. Keyes' theory was that the difference between complete incontinence and complete dryness is not the difference between a widely open faucet and a tightly closed faucet, but rather the difference between a faucet that drips very slightly and a tightly closed faucet. Consequently one may expect, occasionally at least, to close such a dripping urethra by relatively slight or indirect muscular pressure. Seven months after operation the patient had recovered completely from the incontinence; he did not arise at night; there had been no leaking in several months.

Malignancy.—Bumpus [41] reports five cases of sarcoma of the prostate. The type of sarcoma and the age of the patient largely determine the physical characteristics of the tumor. Thus, a lymphosarcoma, composed almost entirely of a single type of rapidly growing cell and having little or no connective tissue stroma, will usually be felt as a soft boggy tumor of considerable size, often confused with prostatic abscess. A rapidly growing lymphosarcoma was seen in a young adult. The same type of tumor in another case, that of a patient aged 64, gave an entirely different physical appearance, being described as of uniform enlargement, hard, tense and adherent. The presence of lymphosarcoma was not suspected until discovered microscopically. These two cases of lymphosarcoma illustrate the influence of age on the appearance of the tumor: the younger the patient the more rapid the growth of the tumor, and hence the less dense its consistency. In youth, and in middle and old age, therefore, the same type of tumor may present entirely different physical aspects. In a third case, that of a patient aged 69, the tumor had been regarded for three years as carcinoma of the prostate and was so treated because of its hard nodular feel. Yet, when just prior to death an operation for the relief of obstruction became necessary, examination of the removed tissue showed that the tumor was a

40. Keyes, E. L.: An Operation for Incontinence of Urine Following Perineal Prostatectomy, Surg. Gynec. Obst. **42**:423 (March) 1926.

41. Bumpus, H. C., Jr.: Radium and Roentgen Ray in the Treatment of Sarcoma of the Prostate, J. Urol. **14**:519-533 (Nov.) 1925.

fibrosarcoma. A tumor composed so largely of fibrous tissue in a patient nearly 70 was naturally firm, resistant and hard and, without microscopic examination, impossible to distinguish from carcinoma. At the other extreme is a case of myxosarcoma, in a child of 3, which is the large, soft tumor usually associated with sarcoma. Intermediate in physical characteristics is a case of myosarcoma occurring in the sixth decade. As one would expect, the tumor was firm and elastic, but had neither the doughiness of the myxosarcoma nor the firm resistance of the fibrosarcoma. Before the introduction of radium the fatal course of the disease was rapid, and patients did not recover following surgical intervention. According to Bettoni, in twenty recorded surgical cases only two patients lived longer than two months. With radium treatments the results have improved. Young [42] reports two clinical cases so treated. One of these patients had lived four years, the other nine months. In both the huge mass, diagnosed as sarcoma, and which nearly obstructed the rectum at the initial examination, had entirely disappeared.

Gayet and Peycelon [43] conclude from a long and careful study of the treatment of cancer of the prostate that radium therapy has not given the results which were expected at the beginning of its use. The cause remains chiefly in the late diagnosis, the deep location of the lymphatics invaded by the neoplasm, and the difficulty of its application. The surgeon's duty should be to make an early diagnosis and to operate early. If the condition is too far advanced radium should be employed in an endeavor to check the lymphatic invasion as far as possible; if the bladder or the pelvis is invaded, radium is contraindicated. The patient may get relief from pain and may get prolongation of life by palliative operations, such as cystostomy. Radium in cases of extensive growths is dangerous and may induce early metastasis, septic absorption or severe pain.

42. Young, H. H.: Practice of Urology, Philadelphia, W. B. Saunders Company, 1926.

43. Gayet, G., and Peycelon, R.: Contribution a l'etude du traitement du cancer de la prostate, Arch. franco-belges de chir. **28**:759-781, 1925.

(To be continued)

Correspondence

"FRACTURE OF THE HEAD OF THE FEMUR"

To the Editor.—Christopher's valuable case report of fracture of the head of the femur[1] in the May issue has been read with interest, most especially the careful survey made of the literature. He states that reports of only fourteen previous cases were found, and he adds one, concluding that this is a rare injury. We did not realize that this was the case, as two instances of this injury have come under the observation and care of one of us (C. W. P.). The apparent rarity of the lesion, however, would seem to warrant putting these two cases also on record. The second of these patients was admitted to the orthopedic division of the Henry Ford Hospital a little more than a year ago and was treated by the other author, whose detailed report on this patient appears here.

The first patient was admitted in the service of Dr. Z. B. Adams at the Massachusetts General Hospital, Boston, in 1920, and this case is reported here with his permission. The patient, Mary M., a rather stout woman of about 45, was riding in the back seat of a small automobile when a head-on collision occurred. (It may be interesting to note that her sister, sitting beside her, suffered a fracture of the posterior upper quadrant of the acetabulum, with a dorsal dislocation of the head of the femur without fracture of this bone, and later was operated on by Dr. Adams, with a successful outcome.)

The accident occurred almost 150 miles from Boston. A surgeon at the scene of the accident diagnosed the dislocation, but, an attempt at reduction being unsuccessful, sent the patient to the hospital the next day. Physical examination on her arrival showed the deformity and other usual signs of dislocation, but roentgen-ray examination also showed a fracture; a fragment comprising about one fourth of the head of the femur attached to the ligamentum teres remained in the acetabulum. Under general anesthesia, Dr. Adams reduced the dislocation without difficulty, and the limb was put up in plaster in the abducted position for two months. Roentgen-ray examination then showed that the fragment had fitted into its normal position in the head, and had remained so after the removal of the cast at the end of two months. Subsequent observation by Dr. Adams showed permanent union to have taken place and excellent function regained.

The second patient was treated, as stated, in this clinic. This patient was first seen, Nov. 20, 1924, the day of his accident. He said that while driving a small car he had crossed the middle dividing line of traffic, and had been hit by a car coming from the opposite direction. This caused his car to come to a sudden stop. His knees hit the dashboard and remained at a fixed point, while his body continued forward until arrested by the resistance of his hip joints. When admitted to the clinic, he complained of severe pain in the region of the left hip and that he was unable to bear weight on this leg.

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1. Christopher, Frederick: Fractures of the Head of the Femur, Arch. Surg. **12**:1049 (May) 1926.

Clinically examination of the left leg showed it to be internally rotated, flexed at the hip and overlapping the right leg. The diagnosis of simple posterior dislocation of the left hip was made from the clinical examination. (It is of interest to note that the patient sustained a fracture, without displacement of the left patella also, caused by the impingement of the left knee against the dashboard.

Fig. 1.—Left hip, showing dislocated head of femur with fractured fragment in acetabulum.

Roentgen-ray examination showed the left hip to be dislocated posteriorly, leaving, however, about a third of the head of the femur in the acetabulum, to which was attached the ligamentum teres (fig. 1). A small fragment of the posterior upper quadrant of the rim of the acetabulum also was fractured. This fragment may be seen in the roentgenogram taken after reduction (fig. 2). Figure 3 shows the right hip for comparison.

Under ethylene anesthesia, the dislocated hip was reduced, the closed method of Bigelow being used. A Thomas knee splint was applied with traction in a position to hold the leg abducted 45 degrees and flexed 30 degrees at the hip joint. This position was considered the most advantageous to bring the small fragment in apposition with the remaining portion of the head, by putting the inferior part of the capsule on tension. To prevent the formation of

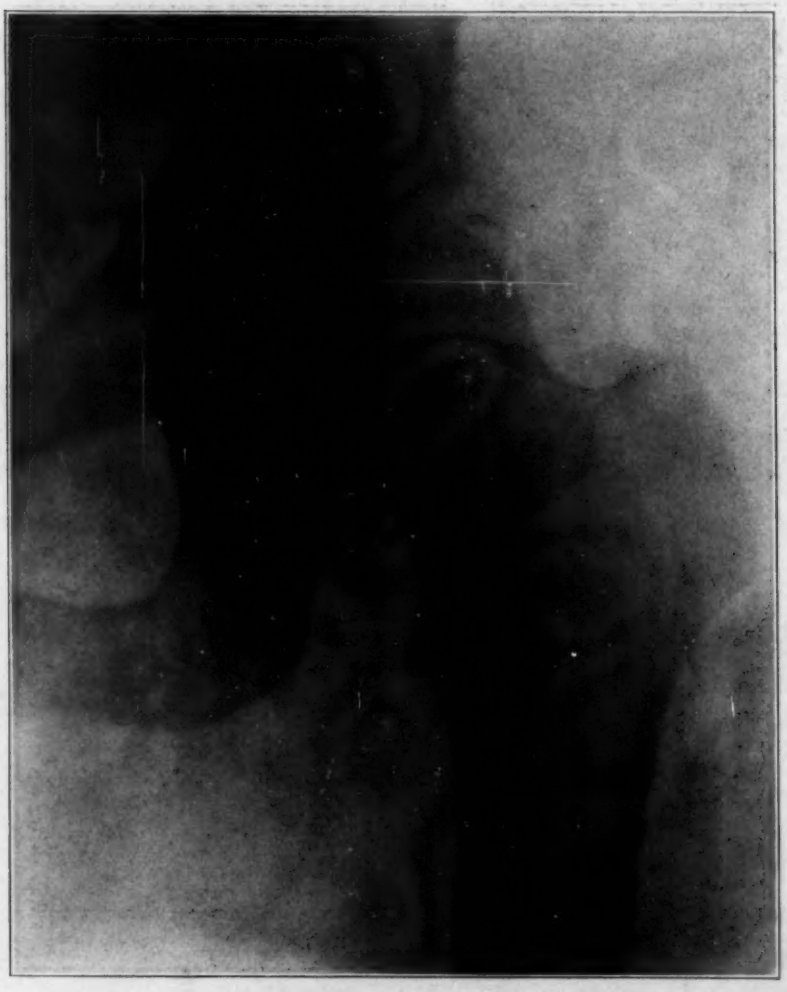

Fig. 2.—Left hip after reduction, showing line of fracture of head of femur and fracture of posterior upper quadrant of the rim of acetabulum.

intracapsular adhesions by the increased relative degree of mobility allowed, a Thomas splint was used at this stage in preference to a plaster spica.

After a period of six weeks, so that he could be treated as an ambulatory patient, a plaster hip spica was applied from the level of the eighth rib on the right side down to the ankle, with the leg abducted 30 degrees and flexed

20 degrees at the hip, and with the knee flexed 10 degrees. In two weeks, the plaster splint was bivalved laterally and removed below the knee. Massage to the muscles of the hip and knee was begun. Later, baking and passive and active manipulations were instituted to the hip and knee.

Fig. 3.—Right hip for comparative study.

After nine weeks the patient was discharged from the hospital, using a Thomas ring caliper with a Bradford abduction bar attached. In two weeks the abduction bar was discontinued, and a month later the brace was discarded. At this time he was able to walk comfortably with the aid of a cane.

At five months from the date of the accident, clinical examination showed that motions in all directions were to the normal range, with the exception

of complete rotation, which was limited 25 per cent. Exercises to increase this range were instituted. Examination at twenty months after the accident showed that the patient had full range of motion in all directions at the left hip. No points of clinical difference could be found on comparative examination with

Fig. 4.—Left hip twenty months after reduction, showing good bony union and position of fracture of head of femur.

the right hip. Functionally, he was able to use the leg to full capacity without any discomfort. Roentgen-ray examination twenty months after the accident showed good bony union between the fragments and the head of the femur (fig. 4).

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